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Holes in the Heavens.

By J. E. GORE, F.R.A.S.

THERE are many dark spots in the Milky Way which seem to be openings or holes in that wonderful zone of stars. These dark spots or "coal sacks," as they are also called, seem to have been first noticed by Pinzon, in 1499. They were also described by Lacaille in 1763.

The most remarkable of these spots is the well-known "Coal Sack" near the Southern Cross. It is of roughly oval or "pear-shaped" form, about eight degrees in length by five degrees in width, and forms a conspicuous object in the sky of the southern hemisphere. It is completely surrounded by the nebulous light of the Milky Way, which is here of considerable brilliancy. The bright stars α and β Crucis—the brightest stars of the Southern Cross—nearly touch its south-eastern edge. It contains only one lucid star within its boundaries. With reference to its northern border, Sir John Herschel says: "The transition from rich Milky Way to almost complete darkness is here very sudden." It is, however, by no means devoid of faint stars. On a photograph taken in 1891 by Mr. H. C. Russell, at the Sydney Observatory, numerous very small stars are visible, but there are several spots which seem to be completely void of stars, and absolutely black. One of these remarkable holes is near β Crucis, and another near α Crucis.

There are other remarkable "coal sacks" in the Milky Way. A long, narrow, dark spot runs from α Centauri, for several degrees towards the north-east. There are several in Scorpio, one of larger size between β and ϵ Cygni, and one south of α Cygni.

Examined with a telescope, the Milky Way shows many examples of small coal sacks; and some may be seen with even a good binocular field glass. One night when Sir William Herschel was examining a part of the Milky Way closely east of the globular cluster 80 Messier, which lies between ν and σ Scorpii, he suddenly exclaimed to his sister—the famous Caroline Herschel—"Hier ist wahrhaftig ein Loch im Himmel" (Here, truly is a hole in the Heavens). It was an absolutely black vacuity, about four degrees in width, perfectly free from any stars, and especially remarkable owing to its proximity to one of the richest globular clusters in the heavens. Closely south of Herschel's dark "hole" just mentioned, Professor Barnard has photographed a great nebulous region surrounding the stars ρ Ophiuchi and 22 Scorpii.* This photograph shows several dark lanes in what seems to be at least a comparatively thin sheet of stars, and this distinguished astronomer thinks "it is certain that these stars are at the same distance as the nebula, for they form part of it." With reference to the Milky Way in general, he thinks that the stars comprising it are "comparatively very small bodies, and that they consequently differ vastly in point of size, at least, from the ordinary stars of the sky." If this be so, and the evidence seems to point in this direction, it would follow that their distance from the earth is not so great as their faintness would lead us to imagine. In his *Cape Observations*, Sir John Herschel gives a list of 49 spots in the southern hemisphere "totally devoid of any perceptible star." But probably photography will reveal the presence of some faint stars in these dark spots.

Closely east of the star θ Ophiuchi is a "dark chasm," which passes south and west of that star, and there are several other dark "lanes" and holes clearly visible on the photograph taken by Professor Barnard at the Lick Observatory.

Another small black spot was observed by Barnard a little north-west of the star γ Sagittarii. This seems to have been previously seen by Trouvelot, who says: "C'est comme un sac à charbon en miniature, ou une ouverture de la Voie lactée à travers laquelle la Vue pénètre au dela de ce grand assemblage d'étoiles."

A little south-east of α Cephii, a photograph by Barnard shows a ring of nebulous light, with a comparatively dark interior, at least the stratum of stars filling the rings seems pierced by several holes.

The "key-hole" openings in the great nebula surrounding the variable star η Argûs is a remarkable feature of that wonderful nebula. A little south of this hole there is a "kidney bean" shaped opening, shown in Sir John Herschel's drawing in the *Cape Observations*. This opening is visible on a photograph taken by Sir David Gill in March, 1892. The photograph confirms the accuracy of Herschel's drawing, and shows that the opening is in all probability a real hole through the surrounding nebulous matter.

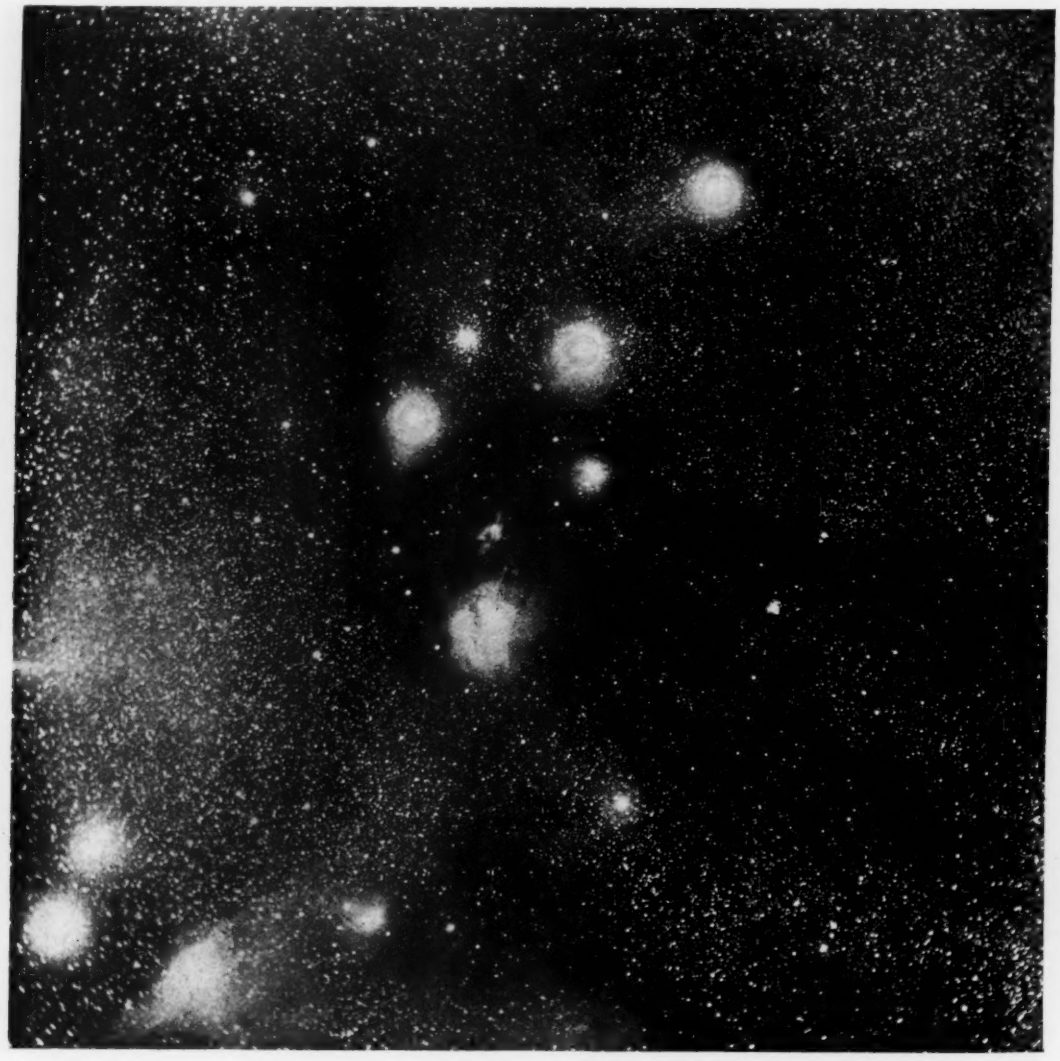
In the region round the star 12 Monocerotis there is a remarkable nebula of irregular shape, somewhat resembling in its general character the great nebula in the "sword" of Orion. Dr. Roberts, describing a photograph he took of this nebula, says: "Some remarkable tortuous rifts meander through the nebulosity on the *north preceding* half of the nebula; their margins

* The rings round the brighter stars in the photograph are due to a photographic effect, and do not exist in the sky

are sharp and well defined in the midst of dense nebulosity. They are as clearly cut as we see the canyons of great rivers, but their width may in reality be millions of miles, for we have no reason to assume that the nebula is nearer to the earth than the stars. It is, indeed, possible that the stars which dot the surface are nearer to us than the nebula."

About 3 degrees north-east of the star θ Canis Majoris is another nebula of irregular shape. Dr. Roberts says that the star D.M. 1848 "is on the margin of a dark sinuous vacancy or rift in the nebula, through which we see into the starless vacancy of space beyond it." This opening closely resembles the "key-hole" opening in the great nebula in Argûs. Dr. Roberts adds: "These vacancies are most conspicuously seen where the surrounding nebulosity is dense, though they are also visible in some parts where it is relatively faint. The margins of the vacancies are often sharply defined, and suggestive of the idea that in consequence of some internal strain, operating from opposite directions, the nebula was rent asunder, and the parts separated from each other."

In another nebula in Monoceros, photographed by Dr. Roberts, a little west of the triple star 15 Monocerotis, there is a remarkable vacuity or hole. Dr. Roberts calls it a dark tortuous rift, and says: "The rifts prove that the nebulæ are not globular, but are like clouds with relatively small depths, and that we can see through them into the darkness of space beyond." There are also very noticeable areas devoid of stars in the region surrounding the nebula.



Great Nebula near ρ Ophiuchi.

(From a photograph by Prof. E. E. Barnard, of the Lick Observatory.)

On July 12, 1891, Professor Max Wolf, of the Astrophysical Observatory of Heidelberg, discovered three dark markings in the Milky Way, about $1\frac{1}{2}$ degrees west of the star γ Aquilæ. He calls them the "Triple Caves," and they certainly present a very re-

markable appearance on his photograph. Closely east of the same star, a photograph taken by Barnard shows some curiously shaped dark markings, which seem to be openings through the Milky Way in this region. On a photograph by Max Wolf, of the region near ξ Cygni, there is a remarkable black hole and some smaller ones.

The question naturally suggests itself, what is the real nature of these curious black spots? Some astronomers have suggested that they are due to masses of cooled down, or partially cooled down, nebulous matter which absorbs the light of stars behind them. The term "hole," which I have used in the present paper implies that my own view is that they are really holes or openings through the regions of stars or nebulous matter, and in this view of the matter I am supported by the opinion of several astronomers, as some of the extracts quoted above will show. Photographs of the great "Coal Sack" near the Southern Cross prove conclusively, I think, that the darkness of this remarkable spot is due to a real paucity of stars compared with the richness of the surrounding regions, and probably the same thing is true of the other dark spots in the Milky Way. We have really no evidence of the existence of dark bodies in space. Professor Newcomb thinks that there is probably little or no extinction due to dark bodies, and he says, "We may say with certainty that dark stars are not so numerous as to cut off any important part of the light from the stars of the Milky Way, because, if they did, the latter would not be so clearly seen as it is. Since we have reason to believe that the Milky Way comprises the more distant stars of our system, we may feel fairly confident that not much light can be cut off by dark

The Milky Way round θ Ophiuchi.

(Photographed by Prof. E. E. Barnard.)

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bodies from the most distant regions to which our telescopes can penetrate. Up to this distance, we see the stars just as they are."* The companions of some of the Algol variables are usually spoken of as "dark bodies," but I have shown elsewhere that we have no reason to think that they are really dark. The companion of Algol, for example, may be a star of the 5th magnitude—a comparatively bright star—and yet be quite invisible to us, as neither the telescope nor spectroscope would show any trace of its existence. The little evidence we have tends to show that the satellite of Algol is *not* a dark body. The idea of "dark bodies" and "dark stars" seems to have been based on the existence of this eclipsing satellite; but it has been recently found that a difference of brightness of two magnitudes between the components of a spectroscopic binary star—like Algol—would be quite sufficient to obliterate the spectrum of the fainter star, the spectroscope merely showing the spectrum of the brighter component. Dark bodies *may* exist in space, and probably do, but as yet we have no positive evidence of their existence. The "holes in the Heavens" are, I think, real, and "dark companions" of Algol variables have probably no existence except in the imagination of some astronomical writers.

It has been stated by several writers that the existence of these "holes" indicates that the Milky Way has a small extension in the line of sight; or, in other words, that it forms a comparatively thin stratum of stars. But Professor Seeliger has shown that, according to the Law of Probabilities, if the number of stars be the same in both cases, the probability against the occurrence of these holes is just *the same* whether the extension of the Milky Way in the line of sight be great or small.† We cannot, therefore, come to any conclusion as to the actual thickness of the Milky Way from the appearance of these dark spots. It may have a great extension in the line of sight, or it may be comparatively thin in that direction. The cause of these "holes" must probably be looked for in the influence of some "clustering power," as Sir William Herschel termed it, which tends to draw the stars away from certain spots and accumulate them in others. The existence of globular and other clusters close to dark and comparatively starless spots seems very suggestive in this connection. If these dark spots were due to intervening dark bodies, there seems to be no reason why we should find them so often close to rich regions.

* *Harper's Magazine*, October, 1904.
† *Astrophysical Journal*, Vol. 12, page 377.

Eels and Electric Light.

IT appears tolerably certain that some species of eels migrate into the sea to spawn, and that the spawn hatches in the sea while the young undergo their transformations near seashores. A belief, which is more doubtful of proof, is that the conger-eel does a good deal of damage to the coast fishing industry, and that this animal has so great a dislike to light that it will not migrate to the open sea when the moon is at the full. An experiment which will resolve some of these doubtful questions is to be made under the auspices of the Biological Society of Copenhagen. In the strait known as the "Little Belt," electric lamps are to be fixed at the bottom of the channel in order to deter the congers from making their way out to the open sea. The result of the experiment will be watched with much attention, both as regards the distribution of the congers and the effect on the shoals of food fishes.

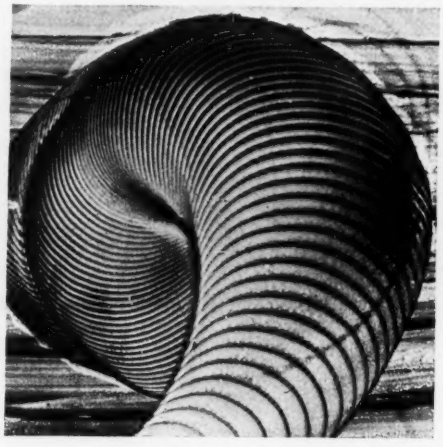
Royal Society.

Ladies' Conversazione.

THE second soirée of the Royal Society, that to which it is customary to invite ladies, was held at Burlington House towards the end of last month, and attracted a large and representative gathering. Some of the exhibits shown in May were repeated, but notwithstanding this there was a goodly number of fresh ones possessing intrinsic interest of which mention may be made here.

Voice figure—landscape pattern.

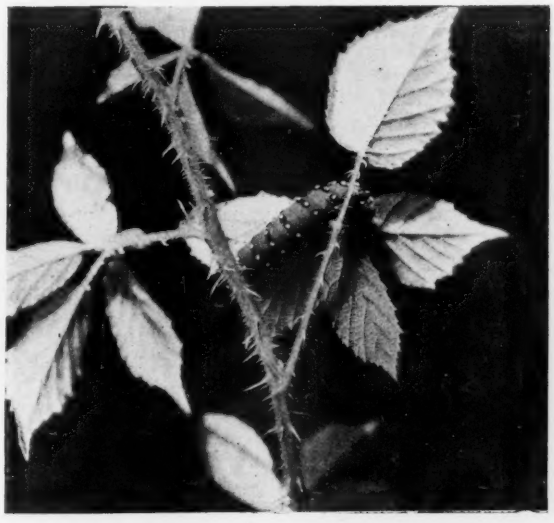
The pretty series of voice figures exhibited by MRS. Watts-Hughes, with the able co-operation of Mr. Richard Kerr, F.R.A.S., were of singular interest. They were entirely produced by the vibrations of notes sung into a tube communicating with a cup-shaped



Voice figure—convoluted pattern.

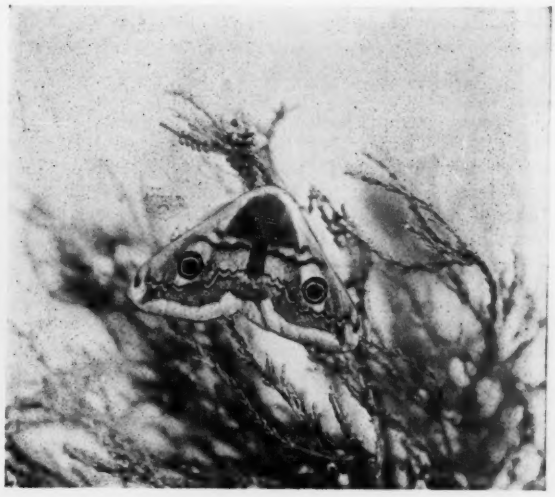
vessel, a piece of india-rubber being tightly stretched over the top of the vessel; on this latter there rested a piece of paper covered with moist water-colour. As the sound waves impinged upon the under-side of the membrane a variety of devices arranged themselves

without any kind of manipulation. Outline forms in natural colour resembling daisies, pansies, ferns, and trees, as well as geometric patterns, were produced, some as the result of high notes, others of low notes. Certain patterns required the notes to be softly sung, while others were the outcome of powerfully-rendered



and sustained notes. A piece of glass, with spread moist water-colour, placed on the vibrating film, showed, when raised, patterns similar to the concentric rings of timber growth. On giving a spiral motion to the glass or to the vessel, simultaneously with the singing of the note, a series of waves in cornucopia fashion may be made to extend over the surface, producing a beautiful object for lantern displays.

One of the most attractive exhibits was that of Mr. F. Enock, who, by means of natural colour lantern slides, showed and described the adaptability of lepidopterous insects to the changeful circumstances of their environment—Nature's own way of protecting insect life. The illustrations which we give fail to convey an adequate idea of the manifold colours thrown upon the screen referring to instances of protective resemblance. No more fascinating study we may well imagine could engage the naturalist's attention than this method of reflecting the doings of the insect world. We see in the first reproduction the larva of the Emperor Moth (*S. carpini*) ensconced and at rest on bramble; the leaves of the plant match the larval body colour, while the



spiny tubercles successfully strive to imitate the thorns. The female moth of the same species is seen at rest on heather, after ovipositing on the tips of the stems. The eggs are so cleverly arranged as to resemble the buds of the plant, being of the same size, as well as quadrangular in plan. Yet another example is that of the Orange Tip butterfly, which rests with wings closed

amongst the flowers of the umbelliferous plant, Fools' Parsley. When "working" the flower, the insect's wings are wide open, but let a cloud or shadow pass over, and they immediately close together as depicted in our photograph (near cross), the protective green coloration and irregular mottlings effectually masking the living butterfly and rendering it almost indistinguishable from

its floral surroundings. The rolled-up leaf, adjacent to the birch leaf in the fourth illustration of this series, is the chosen home of a beetle. Its twig-like companion is none other than the larva of a Thorn Moth (*S. illumaria*).

The advantages of the three-colour process of photography were also apparent in Mr. W. Saville-Kent's brightly illuminated transparencies illustrating the fauna of the Polynesian coral reefs, especially those referring to the gaily coloured fishes which make the recesses of such coral growths their habitation. A striking series of specimens of fossil plants from the English coal measures, with illustrative microscopical slides, was on view, a display with which Miss M. Benson, Miss W. Brenchley, Prof. F. Oliver, F.R.S., and others were identified. A newly discovered petrified stem from Shore, Lancashire, indicated the structure to be of a type hitherto unknown. Some models of branching stems, which furnished accurate reconstructions of petrifications, were, too, of great interest.

Sir William Crookes conducted an elaborate series of experiments in illustration of some properties of the diamond. The squeezing of a natural crystal into steel by means of hydraulic pressure in order to demonstrate the hardness of diamond was beautifully shown by the optical projection upon a screen of the slow transit of the object into the metal until it became lost to sight. In the electric arc the precious gem was seen burning up and turning into graphite. The facile manner in which it will plane a glass surface was shown by a slide of curly glass shavings. One diamond thrown upon the screen had been obtained from the remarkable Canyon Diablo meteorite, of Arizona. Prof. W. Gowland also showed under the microscope diamonds found in this meteorite. Some will, perhaps, remember that it was this particular meteoric mass that secured the ubiquitous attentions of American speculators a year or so ago, when the inevitable company was formed, with the idea—of course a futile one, of exploiting it for diamonds.

From the Royal Institution laboratory came Sir James Dewar's new charcoal calorimeter and thermoscope. In this instrument charcoal when utilised at the temperature of liquid hydrogen and in conjunction with certain gases exhibits great sensibility to heat and light radiation, and can be used in calorimetry. There were also spectrum tubes containing helium, neon, krypton, and xenon, these gases having been separated by the charcoal method. A demonstration of the scientific uses of liquid air formed a popular feature. The fine piece of photo-micrographic apparatus for ultra-violet light, designed by Dr. Köhler, and ably explained by Mr. Max Poser, of the firm of Zeiss, was considered by physicists present to be a splendid instrumental achievement. It was suitably shown for the first time in this country at the soirée.

In archæology, Dr. Flinders Petrie contributed examples of black incised pottery from Egypt, of date 2000 B.C., as well as photographs from Sinai taken during the progress of his recent exploring expedition in that quarter.

Lastly, we should not omit to mention a set of diagrams sent by Prof. Karl Pearson, F.R.S., and Mr. J. Blakeman, illustrative of Lord Rayleigh's solution of the "problem of the Random Walk," a mathematical excursion, decidedly perplexing, however, to the layman. For information on the subject, our readers should refer to *Nature*, Vol. 72.

Some Rudimentary Structures.

By R. LYDEKKER.

ON a first visit to an English assize court, the stranger, if he occupy a sufficiently elevated position, will scarcely fail to notice the presence of a small black patch on the top of the full-bottomed wig of the presiding judge, and, if he be of an inquiring disposition, he will want to know the reason for this apparently useless feature. Reference to any treatise on the history of costume will inform him that this apparently unmeaning patch is the last remnant or survival of the coif, or black cap, with pendent lappets, originally worn by the "sergeants learned in the law," from among which body the judges were formerly selected. The patch affords therefore an excellent example of a structure which, although now perfectly useless, once had a definite and more or less important function. In other words, it exactly corresponds to what are commonly called rudimentary structures in the animal kingdom. I say commonly called rudimentary structures, purposely, because in scientific circles they are now more generally designated vestigiary structures; and, strictly speaking, quite rightly so, for a rudiment properly means the commencement of any thing, whereas these are the last vestiges of the structures they represent. They are decadent, and not incipient. Nevertheless, since the term vestigiary is somewhat cumbrous, and by no means so well known as rudimentary, I shall take leave to use the latter, especially as it is employed by Darwin, in this sense, in the "Origin of Species."

Rudimentary, or more or less completely functionless organs are extremely common in both the animal and the vegetable kingdoms; and they can have but one meaning. That is to say, they afford practically decisive and irrefutable evidence in the minds of all unprejudiced persons of the truth of the doctrine of evolution. For it is absolutely inconceivable that such useless structures, which in many instances can be traced by regular gradations into those which were evidently functional, could have been created in their present condition. Indeed, if we had no other evidence in favour of the evolution of animal forms from pre-existing types, it is perhaps not too much to say that the evidence of these rudimentary structures would alone be sufficient to prove the truth of that great doctrine.

Since rudimentary structures are so common in nature we suffer from an *embarras du richesses* in attempting to select instances to form the subject of an article of the length favoured by the Editor of this journal; and the reader must consequently be not surprised if he finds no mention of many cases of this kind with which he may be more or less familiar. As a matter of fact, cases of this nature to which the present writer has had occasion to devote special attention form the chief of those noticed in this article.

Among the larger animals of the present day, no species is more highly specialised than the horse (and its immediate relatives), and it would consequently be only reasonable to expect that in the course of its evolutionary progress this creature should have found certain elements in its organisation superfluous, and should therefore have done its best to discard them. This expectation is fully realised by the actual state of

the case; and it may be regarded as a fortunate circumstance that the total elimination of such superfluous structures appears to be an exceedingly difficult process, so that their rudiments, or vestiges, are frequently left to tell the tale of their gradual degeneration.

As regards some of the rudimentary organs occurring in the horse, one of the most interesting is the remnant in the skull of the Eastern breeds, of the cavity in front of the eye, which, in the extinct three-toed hipparions probably contained a gland similar to the larmier, or face-gland, of deer and many antelopes. Fuller reference to this rudimentary gland-cavity, which is often very faintly marked, will be found in "KNOWLEDGE & SCIENTIFIC NEWS" for August, 1904.

At first sight there may seem to be little, if any, connection between this last vestige of the hipparion's face-gland, and those curious warty structures on the inner side of the limbs of the horse, which are commonly known as callosities, or chestnuts (Fig. 1). It appears to be a very general belief that these structures

Fig. 1.—The Left Fore and Hind Limbs of a Horse, to show the Callosities, or "Chestnuts."

are for the purpose of serving as cushions, or pads, to ease the pressure on the limbs when the animal is lying down. This, however, is obviously out of the question; and it is quite certain that the callosities are now useless remnants of structures that were once functional. The question is, what those structures were. One theory is that they were foot-pads, or cushions, comparable to those on the foot of a dog or a cat; and in order to support this hypothesis, it has been stated that they are situated much lower down in the fœtus than in the adult, so as to be situated on what corresponds to the foot of other mammals. This, however, is not the case, as is demonstrated by specimens exhibited in the Natural History Museum.

A much more probable theory is that these callosities represent scent-glands, comparable to those on the limbs of deer. Strong support to this is afforded by the fact (as I am informed) that the secretion which exudes from these callosities when cut will cause a horse to follow any substance anointed therewith; and also by the poacher's practice of carrying a fragment of one of them to keep his dog quiet. That a rudimentary foot-pad would have any effect of this kind is, of course, quite out of the question, although nothing is more likely than that such emanations should proceed from a decadent foot-gland.

In regard to the connection between the rudimentary face-gland of certain horses, and the callosities, it may be noted that both face-glands and foot-glands appear to be for the purpose of aiding animals in finding the whereabouts of their fellows; the leg or foot glands leaving a scent on the grass or jungle through which they pass. If, however, animals live on open plains, as is the case with horses and zebras, where they can see one another at long distances, such aids may be quite unnecessary. We know that the horse and its kindred have lost the facial scent-glands of their ancestors, and what is more likely than that they should at the same time have discarded their leg-glands, of which the callosities are the last remnants?

That the horse does retain vestiges of the foot-pads of its ancestors, who applied a portion of the sole of their foot, instead of only the nail (hoof) of the middle toe, to the ground, appears, however, to be undoubted. At the hinder basal extremity of the second joint of the pastern is a curious little horny spur (very conspicuous in the fœtus), known to veterinarians as the ergot; and this ergot seems to represent the central pad of the foot of the tapir. As this part of the foot of the horse does not touch the ground, the pad is of no functional importance, and has consequently degenerated to this curious little horny spur.

Other rudimentary organs in the horse are the splint-bones lying on either side of the upper end of the fore and hind cannon-bones, and representing the functional metacarpal and metatarsal bones, and sometimes even the lateral toes of the hipparion. In domesticated horses not only are these bones useless, but they are actually harmful, producing the disease called splint. How this accords with the theory that the horse has been specially evolved for the use of man, may be left to those who hold that theory to explain. Even this does not exhaust the list of rudimentary structures in the horse. In the "knee," or carpus, of the hipparion exists a bone known as the trapezium, which supports one of the aforesaid metacarpal bones of the lateral toes. In the horse this bone is functionless and very minute, and is present only in about fifty out of every hundred individuals; so that it is evidently about to follow in the wake of the lost lateral toes.

In the horse only certain elements of the limbs have become rudimentary, in order to permit the greater development of other elements of this part of the skeleton. In some groups of animals on the other hand, one or both pairs of limbs are, in many instances at any rate, completely wanting; and had it not been that they are occasionally represented by minute vestiges, we should have had no direct evidence that they ever existed in the group. As it is, we are absolutely certain (if evolution be the true explanation of the resemblance of animals to one another) that snakes and whales are descended from creatures with four limbs.

In regard to snakes, most members of the group, show no traces of limbs, either externally or internally; but in the family groups which include the boa-constrictors and pythons (the *Boidæ* of naturalists) it fortunately happens that in many species, at any rate, minute vestiges of the hind-limbs are retained, as if for the very purpose of telling us the story of their ancestry, for it is quite certain that in most instances at all events, these rudiments are absolutely useless,

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The second illustration to this article shows the external vestiges of the hind-limbs in an African python (*Python sebæ*) over twenty feet in length. These vestiges take the form of a pair of horny spurs, or claws, about three-quarters of an inch in length, and situated on the under surface of the body at the commencement of the tail. In the specimen figured, the skin has been slit along the middle line of the belly, so that the two claws are separated from one another by the width of the skin of the back and flanks, whereas in nature they would be comparatively close together. Each claw in this specimen was supported on a bony core, corresponding to the terminal bone of one of the toes of a lizard's foot, while embedded in the flesh beneath was a much stouter bone, probably representing the femur, or thigh-bone, and also a minute nodule, which may be the last remnant of the pelvis. It must not, however, be supposed that all pythons exhibit these vestiges as distinctly as in this specimen. On the contrary, in the skin of a Malay python (*P. molurus*) of five-and-twenty feet in length, which I recently ex-

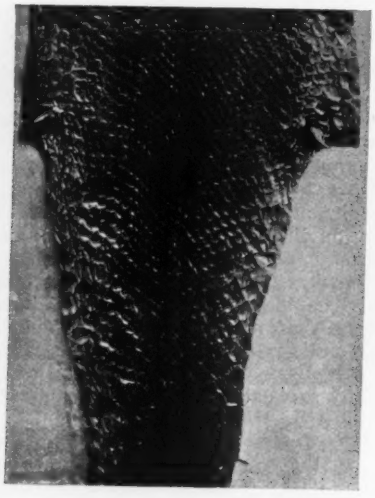

Fig. 2.—Part of the Skin of the Tail of a Python, showing the Horny Spurs representing the Hind-Limbs.

amined, the external rudiments of the limbs were minute lobes, scarcely larger than the head of a big pin. Somewhat similar vestiges of the hind-limbs are retained in the small burrowing tropical snakes of the family *Typhlopidæ*, as well as in the members of a nearly allied group; but in no snakes have any traces of the front-limbs been detected.

These vestiges, then, afford decisive evidence that snakes are descended from reptiles with functional hind-limbs, from which it may also be inferred that their early ancestors were four-limbed; the front limbs, as in the case of certain snake-like lizards, being the first to disappear. The further inference that those snakes which retain rudimentary hind-limbs are the most archaic members of their kind, has been recently confirmed by the discovery that pythons and boa-constrictors display certain primitive features in other parts of their anatomy.

Space admits of but very brief allusion to the case of whales. As everyone knows, all the members of the order Cetacea, inclusive of whales, dolphins, porpoises, &c., have but a single pair of limbs, the front ones, which are modified into paddles for swimming. It is, however, far less well known that deep down among the muscles of the body of the Greenland right-whale and its immediate relatives are embedded certain small and useless bones which represent those of the pelvis, and part of the hind-limbs of less specialised mammals. These rudimentary bones are alone sufficient to demonstrate the descent of whales and dolphins from four-limbed ancestors; and when taken in connection with the fact that cetaceans are air-breathing (as opposed to gill-breathing) creatures, lead to the conclusion that their ultimate ancestors were terrestrial. Curiously enough, it is the most specialised whales (that is to say, the true, or whale-bone whales) that alone retain rudiments of the hind-limb itself; these vestiges in the toothed whales, such as the sperm-whale and dolphins, being restricted to the bones of the pelvis. In this respect, then, cetaceans are unlike snakes, in which, as we have seen, it is the most primitive forms that alone retain vestiges of limbs.

Turning to the subject of the third illustration, we have an exceedingly interesting example of a more or less completely rudimentary structure, in the so-called worm-like appendage, or *appendix vermiformis*, of the human blind gut, or *cæcum*. In this connection it may be well to mention incidentally that the disease to which this organ is so frequently subject, derives its name of *appendicitis* from the organ itself, and its al-

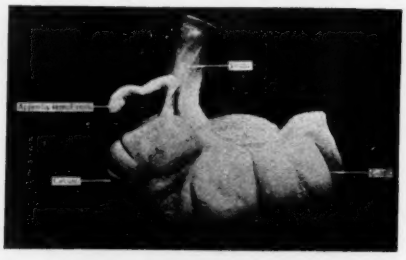

Fig. 3.—The Vermiform Appendix, and the adjacent parts of the Human Alimentary Canal.

ternative title of *typhlitis*, from the Greek τυφλός, blind, in reference to the blind gut of which the appendix forms the termination.

In a great number of mammals, both herbivorous and carnivorous, there exists at the angle formed by the junction of the small intestine or ileum with the large intestine or colon, a large blind pouch or diverticulum, which probably aids in the digestion of food by preventing its too rapid discharge. The cæcum, as it is called, is remarkably well developed in the horse and the dog, in the latter of which it is coiled in a spiral manner. In the human subject, on the other hand, the cæcum proper is very short, but is prolonged by the aforesaid vermiform appendage, which is usually from four to five inches in length, with a calibre of only about one-third of an inch. This appendage corresponds to the coiled cæcum of the dog, of which it is obviously an aborted rudiment. As many of us know by sad experience, it is only too likely to become choked by closely packed, partially digested, or undigested food; and the opinion has been very generally held that it is an altogether superfluous and useless organ whose complete elimination would be an unmixed advantage to the human race. For instance, on page 282, of "The Student's Darwin," by Dr. Aveling, we find the following statement in reference to the vermiform appendage:—

"It is to man useless. Nay, it is worse than useless. It is at times a special death-dealer. Small, hard bodies, as the seeds of fruits, entering the appendix, cause inflammation and death. In the animals lower than man, this organ is of great size and functional importance. That of the orang-utan is long and convoluted."

On the other hand, an eminent surgeon has recently expressed the opinion that the appendix may still have a certain amount of digestive function. To controvert such an opinion would obviously be presumption on my part; but whether or no it still retains any active function, the structure in question is evidently a pronounced example of a rudimentary organ, and one which, by the way, leads to the conclusion that man is descended from an animal furnished with a long and complex cæcum. Incidentally, it may be mentioned that, in addition to man, the only animal possessing a vermiform appendix is the Australian wombat, a member of the marsupial order. Truly a remarkable instance of parallelism in retrograde development!

With Figure 4, I come to the last section of my subject, and I must confess that I am by no means certain that it properly belongs to my subject at all. The object represented on the left side of the photograph in question is the tip of the tail of a lion, showing the presence of a small horny prickle or spur (*s*) buried among the terminal tuft of hair. In the natural condition, it should be mentioned, the spur was completely concealed by the long hair, and it was only by cutting away a portion of the latter that it was made visible. What may be the history or use (if it has a use) of this spur, no one seems to know, and I have no intention of hazarding a guess. The old story, that it was for the purpose of enabling the lion to goad itself into a fury when about to attack, is obviously an absurdity, more especially as it seems that the spur is

Fig. 4—Tip of Tail of Lion (on the left), and of Nail-tailed Wallaby (on the right), showing Horny Spur and Nail.

developed in only a comparatively small percentage of lions. If any of my readers can solve this problem, they will be the means of removing one blank from future zoological text-books. I fear it will not help them much to learn that one species of kangaroo, or rather wallaby, possesses a very similar caudal appendage, which is, however, of a somewhat more nail-like form, as shown at *N*, on the right side of Figure 4.

It may be added that all the figures in this article have been reproduced from photographs of specimens exhibited in the Natural History Branch of the British Museum at South Kensington.

The Petrified Forest of Arizona.

THE petrified forest of Arizona is seldom visited because of its inaccessibility to the ordinary traveller, though it is but 2,500 miles from New York. It lies in a district possessing archæologic attractions as well as geologic problems, for the village of Adamana, in Apache country, which is the only human habitation within easy reach of the forest, is the centre of a neighbourhood full of Indian ruins. The most interesting of these ruins are those of the cliff dwellers who made their homes in the minor bluffs which border the canyons and plateau-like spaces of the petrified forest. The extreme height of these cliffs does not exceed a hundred and fifty feet, but they are identified with the forgotten Indian tribes of the Hopi and Zuni; and an ancient fort together with various rock inscriptions and other relics and ruins give colour to the legend that the Agtees once inhabited this region. The only dwellers now in this great intersected plateau 5,000 feet above sea-level are the historic Navajo Indians. Such are the situations and the surroundings of the petrified forest of Arizona, which is divided into three sections marked by the same general characteristics. Fragments of lava, beds of basalt, and the peculiar pitch of the upheaved strata point to a period of volcanic activity. The first casual opinion that is formed in surveying the petrified tree trunks is that an ancient forest flourished on the spot; that it may have become submerged and petrified under the saline action of some encroaching inland sea, and that centuries after the great winds and sandstorms of the high plateau swept off the covering of sand and silt from the tree trunks. This theory, plausible as it may at first sight appear, must, however, give place to the alternative theory that almost the whole of the vast and remarkable deposit dropped from a neighbouring plateau, where it was for long embedded, and whence it was eventually washed into the valley seven hundred feet below.

Quite apart from the scientific interest of the Adamana forest is its wonderful picturesqueness and beauty. Each step reveals deposits of topaz, agate, cornelian, amethyst, onyx, and chalcedony in such an advanced stage of mineralisation as almost to give them place among gems and precious stones. Chips and segments of gem-like chalcedony, which once were portions of living trees, cover the earth beneath one's feet, and vari-coloured columns (hard as flint and shaded like the rainbow) are huddled around, still bearing the familiar outline of their original forest state. The colours at the sections where the trunks have broken across are always the brightest, and fully suggest the radiant development that can be secured by the lapidary.

In the conglomerate stratum of the plateau are still embedded thousands of tree trunks, some projecting and showing round the bark an encrustation of sandstone, exactly similar to that found on the surface of the trees in the petrified sections at the lower level. Firs and oaks were the main constituents of the once living forest, yet minute search among the deposit, which covers an area of more than eight square miles, has failed to reveal any vestige of acorn or cone. This circumstance, together with the fact that no branches have been found, that none of the trees are upstanding, and that several of the short stumps have the root end

XUM

Petrified Tree trunks near Adamana.

Natural bridge formed by a Petrified Tree trunk in the Arizona Forest.

uppermost, is accepted as strong evidence that the forest did not grow on its present site. There is the further argument that the number of trunks found huddled together all over the area are greatly in excess of the number of trees that could have grown to a vigorous maturity on such a limited surface. That the action of silicification set in after the destruction of the forest is a matter of universal acceptance; yet a very interesting theory could be developed on this point from the existence round the base of the trees of a thick sandstone coating which lessens on, or entirely disappears from, the bark encasing the topmost sections.

In the third and largest section of the forest, thirteen miles from Adamana, there are several hundred whole trunks partly embedded in the earth, some of which exceed one hundred and fifty feet in length. The colours here are very striking, and the crystal deposits of considerable frequency. The second or middle forest is the smallest of the three, but in its two thousand acres are many fine specimens of wood agate, those named the Twin Sisters being the most widely known.

The distance between Adamana and the first forest is only six miles, and on the road between there are prehistoric ruins made out of logs of this fossil wood, which also served for the construction of implements found in Pueblos hundreds of miles away in the desert. The majority of the trees in all parts of the dead forest are broken off in sections, ranging from two to twenty feet, but the first forest, which has a higher altitude, possesses one of the most remarkable exceptions, which unquestionably grew on the spot where it now lies. It measures one hundred and eleven feet in length, with a base diameter of four feet four inches, graduating to eighteen inches at the other end, and in its prostrate position it spans a fifty feet wide canyon, making a unique natural bridge over the intermittent river, whose bed is twenty feet from the canyon's edge.

An Interesting New Asteroid.

ON February 22, 1906, a new asteroid was detected by Max Wolf at Heidelberg, which was found to have a remarkably small rate of retrogradation, about 30 secs. daily. The provisional designation of this body is TG. Later Dr. Berberich deduced circular elements for the asteroid, which indicated that its mean distance was 5.05, almost identical with that of Jupiter, and from more recent observations, April 22, combined with those of February 22 and March 23, has computed elliptic elements. These show a mean distance a little greater than Jupiter, and aphelion distance about one unit beyond the orbit of Jupiter. A. C. D. Crommelin draws attention to the fact that the family of asteroids now extends from distance 1.1 (perihelion of Eros) to distance 6 (aphelion of TG), and in consequence the investigation of the perturbations of TG by Jupiter should prove very interesting on account of the equality of their mean motions. In the present positions of the orbits no very close approach occurs.—(*Observatory*, June, 1906.)

"THE value of glass may far exceed that of gold," says *Amateur Work* (Boston). "A contemporary draws attention to its enormously increased value when made up into microscope objectives. The front lens of a micro-objective, costing 5 dollars, does not weigh more than about 0.0018 gram, which weight of gold is worth about one cent, and so the value of a kilogram of such lenses would be about 3,000,000 dollars. The cost of the raw material for making this weight of glass is from 5 cents, and thus, when worked up into the shape of a lens, the glass has been increased in value about fifty million times. Such disparity between the cost of the raw material and the manufactured article is probably a record in industrial technics."

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Efficiency of Shutters.—Although shutters are now very commonly employed, there are many false ideas held with regard to them. It has been stated so frequently that it seems to be commonly accepted as a fact, that focal-plane shutters give an efficiency of one hundred per cent. Before making any precise statements, it is necessary to make clear what is meant by the word *efficiency*. If it is defined as the ratio between the actual period of the exposure and the time that would be necessary to produce the same light effect if the shutter were removed, that is, if the opening and closing took no time at all, then the focal-plane shutter is the least efficient of any pattern, for the time taken for the narrow slit to pass across the front of the plate is always considerable, because of the great distance it has to travel. But if efficiency is taken as applying, not to the whole plate, but to each point of it separately, so giving the focal-plane shutter all possible advantage, still its efficiency is not, and never can be, one hundred per cent. Considering shutters of all classes so far as I know them, the general statement, that in giving their minimum exposures the efficiency tends towards fifty per cent. may be accepted as correct. That is, the actual period is about twice as long as would give the same light effect if the uncovering and re-covering of the plate or lens took no time at all. The application of this principle to the focal-plane shutter is not generally appreciated. By reason of the exigencies of construction the slotted blind must be an appreciable distance in front of the sensitive surface, and the aperture of the lens must be considerable. It therefore follows that each edge of the opening gives a penumbra, and that the exposure of every point of the plate begins gradually, increases to a maximum, and then diminishes to zero, as in all other shutters. There are some shutters that give an efficiency of less than fifty per cent., but this is because either of faulty construction or the endeavour to get an exposure that is shorter than the apparatus will properly give. The advantage of the focal-plane shutter is not in its greater efficiency when giving its minimum exposure, but that its shortest exposure (having regard to only one point of the plate) is, say, about a tenth of the shortest exposure given by a lens-shutter, so that in giving the same exposure with both of, say, the one-hundredth of a second, the lens-shutter is working at its quickest and with its minimum efficiency, while the focal-plane shutter is giving ten times its shortest exposure with a corresponding gain in efficiency. On the other hand, a diaphragm shutter that opens from the centre will permit of the use of a larger opening in the lens for the same defining power and depth of definition, because the greater part of the exposure is given with smaller apertures than the full, by reason of the shutter acting the part of an expanding and contracting diaphragm. There are many other details that might be referred to in this connection, for the matter is much more complex than it is generally considered to be.

What is the One-hundredth of a Second?.—It is easy to talk glibly of such an exposure as this, and to engrave the fraction on the shutter, but the definition of it is not so simple. Of course, such a period of time

simple enough in itself, but, as applied to photographic exposures, it may mean three distinct things, and which of the three it means I have never been informed when buying a shutter. It may signify (1) the whole duration of the exposure; (2) the effective duration of the exposure; or (3) the equivalent exposure. With all shutters, the exposure begins and ends gradually, and the "effective duration" neglects the time taken up at the beginning and end of the exposure when the light action is so small as to be negligible. The "equivalent exposure" is the duration of an exposure that would give the same light-action if the opening and closing required no time at all. If the photographer has a satisfactory amount of exposure with an aperture of *f*/16, and one twenty-fifth of a second, and he wants to shorten the duration of the exposure and still maintain the same amount of light-action by increasing the aperture of *f*/8 and the shutter speed to one-hundredth of a second, then he wants equivalent exposures marked on his shutter, and this, I believe, is what most people do want. But if he calculates from the rate of a moving object and the permissible blur, the maximum duration of exposure that will conform to his conditions, then he wants to know the effective duration of the exposures. I believe that such calculations are very rarely made in practical work, even in those cases where they would be simple and advantageous. The whole duration of the exposure is of use only in a secondary sense, or under very exceptional experimental conditions.

A New Shutter.—It is risky to call anything new. But I believe the adjective is strictly applicable to a shutter that will shortly be put on the market by Messrs. Taylor, Taylor and Hobson. It embodies several new details, the consideration of which will be found in a communication made by Mr. William Taylor to the Royal Photographic Society, and published eighteen months ago in their Journal. The shutter is diaphragmatic, and acts the part of a diaphragm as well as a shutter by means of a simple contrivance that limits the movement of the leaves, so that the maximum opening is the aperture desired. A separate iris diaphragm being unnecessary, the space that has to be left between the lens components for the working of the shutter is practically the same as is required for the usual diaphragm alone. The shutter has four leaves, arranged like an iris diaphragm, but the edge of each is so cut that the opening made is always eight-sided, a much nearer approach to a circle than is often obtained in such apparatus. The opening and closing is done always at the same rate, the varying periods of exposure being obtained by stopping the movement for the desired time when the opening is at its maximum, and not by slowing the moving parts, so that the longer the exposure the greater the efficiency. For the most usual exposures, the twenty-fifth of a second and longer, the efficiency is, I believe, from over 90 to about 97 per cent., and the difference between such figures and a hundred is negligible in general work. The shorter exposures are arranged to give the due proportion of light effect; they are definitely made to be the equivalent exposures, as explained above. The example I have gives exposures from one second to the one-hundredth of a second. The pneumatic break is exceedingly compact and efficient, and all the mechanism is enclosed so that it is protected as far as possible from dust. I have referred rather in detail to this particular apparatus because it seems to me a distinct advance in shutter mechanism, and, indeed, to leave very little, if anything, to be desired as a shutter for general use.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Constant Deviation Prisms for Radial Velocity Determinations.

AN interesting property of the constant deviation prism was demonstrated recently by T. H. Blakesley, showing that by employing two prisms of the same angle, but inverted with respect to their bases, there would be produced two spectra of opposite sense. When a star was brought into the field the two spectra would, of course, have their colours in opposite directions, and the adjustment would be such as to make any particular line coincident in the two spectra if the light source were at rest; for a body in motion the line would be split up into two moving in opposite directions in the field of view. Measurements of the distance apart of these lines will give the necessary data for calculating the radial velocity of the star.

Work at Greenwich Observatory, May, 1905—May, 1906.

In his report presented to the Board of Visitors on May 30 the Astronomer-Royal briefly summarises the various classes of investigation which have occupied the staff during the past year.

Transit Instrument.—This has been repaired, and owing to some difficulty connected with the repolishing, the instrument was out of use for about two months. During the rest of the year 6,335 transits were observed, and 5,531 observations with the circle. Two hundred and fifty-seven reflection observations of stars were made, and numerous determinations of level and collimation error. The transits are completely reduced to 1905, December 31, and apparent R.A. is formed to 1906, May 6. The circle observations are completely reduced to 1905, December 31, and as far as apparent N.P.D. to 1906, May 6. The new working catalogue of stars of magnitude 9.0 and brighter, between the limits of +24° to +32° of N. Declination, forming reference stars for the Oxford Astrographic Zone, has been completed, and includes more than 12,000 stars, the places of which have been brought up to 1910. A new determination of the pivot errors was made in November, showing them to be insensible.

Altazimuth.—Various adjustments have been made of the object-glass mounting, and the instrument mainly used as a reversible transit. Observations of the sun, moon, planets, and fundamental stars have been made throughout the year.

28-Inch Refractor.—This has been used for micrometric measures of double stars, diameters of Jupiter and its satellites.

Thompson Equatorial.—With the *30-inch reflector* photographs of Jupiter's satellites VI. and VII., minor planets, Nova Aquilæ, Comet α (1905), and various nebulæ were obtained during the year. With the *26-inch refractor* 72 photographs of Neptune and its satellite were taken on 28 nights, and are now being measured.

Spectroscope.—A number of experimental spectra of sunspots have been photographed in the 3rd order spectrum.

Astrographic Equatorial.—One hundred and sixty-four photographs have been taken on 60 nights. Various remeasures of the catalogue plates have been made in the zones 80° to the Pole. A table is given showing the numbers of separate stars measured for zones of 5° in the section allotted to Greenwich, from which it appears that considerably more than six times the number of stars will be included in the resulting catalogue than are contained in the *Bonn Durchmusterung*. Reproductions of enlarged prints of the chart plates have been made as far as possible.

Photoheliograph.—Photographs of the sun were obtained on 210 days. The Thompson telescope was taken to Sfax for the total solar eclipse, and excellent photographs of the solar surroundings obtained. By the co-operation of other observatories photographs were obtained for measurement of spots on faculæ on 364 days during 1905, the missing day being 1905, January 1.

Magnetic Observations.—The principal results for 1905 are as follows :—

Mean Declination = 16° 9′·9 West.

Mean Horizontal Force = { 4·0173 (British Units.) / 1·8523 (Metric Units.)

Mean Dip (with 3-in. needles) = 66° 55′·55″.

In 1905 there were no days of great magnetic disturbance, and only 12 of lesser disturbance.

Personal.—During the year Mr. F. W. Dyson, the chief assistant, was appointed Astronomer-Royal for Scotland, and the vacancy was filled by the appointment of Mr. A. S. Eddington, B.A.

In concluding his report the Astronomer makes some strong remarks concerning the serious interference with the work of the observatory which is caused by the new power station of the London County Council, situated on the riverside, due north of the transit circle, and only about half a mile distant. The tremors caused by the engines are stated to be much more violent than would have been anticipated from experience of the engineering plants that have been carefully tested.

Stereoscopic Determination of Stellar Proper Motions.

Herr Dr. Max Wolf, Director of the Astrophysical Observatory at Heidelberg, has for some years past very successfully employed the stereoscope for detecting asteroids on photographic star charts taken at intervals, and he has recently extended this delicate method of comparison to the determination of proper motions of stars perpendicular to the line of sight. The process involves the operation of comparing, in an ordinary stereoscope, two photographs of the same portion of the sky taken at several years' interval.

In the case of plates of a well-known star submitted to the Paris Academy there is a distinctly visible alteration in the appearance of the star from its surroundings, although the two component photographs were obtained at an interval of only four years. Another comparison refers to a star of the ninth magnitude in Leo, whose proper motion now becomes known for the first time. The two plates for showing this were taken at an interval of fourteen years.

Not only is the detection of proper motion rendered much more easy by this method, but Dr. Wolf is of opinion that its magnitude can be determined more accurately than by the usual micrometric method.

As examples of other problems to which the stereoscopic method of comparison may with advantage be applied, mention is made of the examination of meteors, comets, the lunar mountains, and certain nebulæ (*Comptes Rendus*, 142, pp. 1007-8, May, 7, 1906.

Parallax of Nova Persei.

M. O. Bergstrand has recently endeavoured to determine the parallax of the Nova Persei from observations made at the observatory of Upsala in 1901 and 1902.

His result is

$$\rho = 0''{\cdot}03 \pm 0''{\cdot}01.$$

Distribution of Radium in the Earth's Crust.

An important paper dealing with the results of an investigation of the mode of occurrence of radium in the earth's crust has been communicated to the Royal Society by the Hon. R. J. Strutt. He concludes that: (1) Radium can easily be detected in all igneous rocks. Granites, as a rule, contain most radium; basic rocks the least. (2) This distribution of radium is sufficiently uniform to enable a fair estimate to be made of the total quantity in each mile of depth of the crust. (3) The result indicates that the crust cannot be much more than 45 miles deep, for otherwise the outflow of heat would be greater than that actually observed. The interior must consist of totally different material. This result agrees with Professor Milne's conclusion drawn from a study of the velocity of propagation of earthquake shocks through the interior. (4) The moon probably consists for the most part of rock, and, if so, its internal temperature must be far greater than that of the earth. This explains the great development of volcanoes on the moon. (5) Iron meteorites contain little, if any, radium. Stony ones contain about as much as the terrestrial rocks which they resemble.—(Proc. Roy. Soc., 77A, pp. 472-485, 1906.)

New Method for the Discovery of Asteroids.

An interesting method has recently been adopted by J. H. Metcalf for the photographic determination of asteroids. It may, perhaps, be best described as the inverse procedure to that adopted by Max Wolf at Heidelberg, where the star field is accurately followed by clockwork, and any asteroids present record themselves as short trails among the numerous minute points representing the stars. When the asteroids are in opposition they retrograde about 34″ an hour, and thus in an instrument of large dimensions the trails must of necessity be somewhat faint; therefore a limit is soon reached to the brightness of asteroids which will be detected by the trail. The author, therefore, calculates the mean velocity of the asteroids in the region it is proposed to examine. By inspection of the positions and daily motions given in the *Berliner Jahrbuch*, it is possible to get a close value of the extreme values for the motions of the asteroids already known in a certain region. The general direction of motion will be parallel to the elliptic. By means of a finding telescope with micrometer wire the camera is so adjusted that it can be moved at short intervals in the calculated direction; at the end of the exposure all the stars in the field will be represented by short trails, while any asteroids which may be present will most probably be shown as points or only very short lines. Excellent photographic reproductions of asteroids found in this way are given, one of about the thirteenth magnitude. The author acknowledges the description of a somewhat similar method of photographing unknown objects which was published by E. E. Barnard in 1897.

Testing of Optical Surfaces.

M. G. Meslin describes a very interesting method of testing optical surfaces which is more widely applicable than the now well-known method of using Newton's rings and monochromatic light. By employing a grating instead of the parallel test plate a new series of interference phenomena are brought into play, and the most important factor from a practical standpoint is that these new bands are very distinct in ordinary white light, so that little special apparatus is needed. The grating is placed over the surface to be tested, either in contact or a few millimetres distant.

An interesting distinction of these grating interference bands from Newton's rings is that they are scarcely coloured, being almost achromatic when viewed at an incidence about 45°; further, the diameters of the rings *diminish* when the incidence is increased, whereas Newton's rings *increase* in diameter under similar conditions. They may be rendered very brilliant by increasing the reflecting power of the surface to be tested, say, by silvering, and hence the method may be applied to the examination of metallic surfaces, and also of liquids, such as mercury.—*Comptes Rendus*, 142, pp. 1,039-1,042, May 7, 1906.)

BOTANICAL.

By G. MASSEE.

Protective Adaptations in Plants.

SOME remarkable instances of protective adaptation have been described, and beautifully illustrated, by Sir William Thiselton-Dyer, in the *Annals of Botany*. The plants under consideration are natives of South Africa, and, growing in an arid region, had two problems to face—to reduce to a minimum the loss of water by transpiration, which was accomplished by assuming a spheroidal form, thus presenting a minimum of surface; and, secondly, to secure as far as possible against the danger of such succulent masses

being eaten by animals; this was effected by simulating in appearance the pebbles amongst which they grow.

Mesembryanthemum truncatum grows amongst rolled, water-worn pebbles, which it so closely resembles in form, colour, and mottling of the surface, that it is very difficult to distinguish between the two.

Mesembryanthemum bolusii is even more difficult to detect in its natural surroundings. The mimicry is with angular rock-fragments instead of water-worn pebbles. The plant consists practically of two fleshy leaves of a dull grey-green colour, and the resemblance is enhanced by minute pustular spots, with which the surface of the leaves is studded. The general effect produced is that of a lichen (*Lecanora*) growing on weathered stones. This plant is rendered conspicuous for a short period by its bright yellow flowers.

In a third plant, *Anacampseros papyracea*, also a native of the Karru, the leaves are minute, and are concealed by their large, dry, membranous stipules. The general appearance of the plant is compared to the dejecta of some bird, the branches becoming whitened towards the tips. In this instance, the flowers are very minute, and concealed under the stipules.

New Rubber Producing Plants.

In a Parliamentary Report of a Botanical Mission through the forest districts of Buddu and the Western and Nile Provinces of the Uganda Protectorate, Mr. M. T. Dawe announces the discovery of a considerable number of forest trees, many of which are of considerable economic importance. One of the most important results of the mission was the discovery that the Lagos silk rubber tree, *Funtumia elastica*, was a native of Uganda. During previous years considerable expense had been incurred in introducing this tree for the purpose of forming experimental plantations. This lack of information in the present instance has a compensating advantage, as, had its presence been known to the natives, it would probably soon have been exterminated, judging from the reckless manner in which they collect rubber from other trees.

Two more trees, present in abundance in various districts, *Landolphia dawei*, and *Clitandra orientalis*, will, in the near future, form important sources of Uganda rubber.

Numerous kinds of forest trees, many of gigantic proportions, were observed during the journey, a good percentage of which proved to be new to science. As examples :—

Balsamocitrus, the type of a new genus, has large globose fruits, and the seeds are embedded in a very fragrant balsam. *Canarium Schweinfurthii* is a large tree with an edible fruit containing a quantity of fragrant balsam, used as a substitute for incense in some Catholic churches.

Pencedanum fraxinifolium, a large, umbelliferous shrub, forms a favourite food of elephants.

Balanites wilsoniana, another tree hitherto unknown, has a large fruit, enclosing a seed full of oil. Elephants are very fond of the fruit, and are mainly responsible for its distribution throughout the forest.

Finally, a large toad-stool, common in some districts, furnished with a tapering stem two to three feet long, which penetrates the soft humus of the forest, is used as an article of food by the natives. This also proved to be undescribed, and has been named *Collybia macrorhiza*.

Arctic Flora.

Mr. H. G. Simmons has contributed an interesting account of the higher plants inhabiting the polar region, in *Videnskabs-Selskabet* of Kristiania. Ellesmereland, the northernmost great island of the Arctic-American Archipelago, was the portion investigated, and up to the present has furnished 115 species, belonging to 24 families. The genera containing the largest number of species are *Carex* and *Saxifraga* (11 each); *Ranunculus* (6); *Draba* and *Poa* (5); *Pedicularis*, *Potentilla*, and *Glyceria* (4 each). Of these, only two genera, *Androsace* and *Chrysosplenium*, and the following species, *Alsine Rossii*, *Carex membranopacta*, *Taraxacum pumilum*, and *Poa evagans*, are absent from Greenland. Of the Ellesmereland flora, 72 species are circumpolar plants, spread all over the Arctic region, and also to some extent, outside.

In tropical and temperate regions, it is well known that altitude is a factor of primary importance in determining the distribution of plants. In Arctic regions, this fact does not hold good. The author states that height is of very little consequence, perhaps none at all in these regions. At an elevation of a thousand feet the same species, under favourable conditions, were quite as large and vigorous as when growing at the sea level.

The two important factors are water supply during the period of growth, and exposure. Southern slopes, with the requisite amount of water, always furnished the greatest variety and abundance of vegetation.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Effect of Blows on Chemical Elements.

IT was noticed by Herr Doermer that when metallic calcium was hammered on an anvil there was frequently a fairly violent explosion, accompanied by a flash of light and sparks, and it was found that the explosibility was promoted by the presence of rust on the anvil, or by traces of iron oxide as impurities in the metal. Professor Cohen suggested that the explosion might be due to the calcium having absorbed gases, just, as is well known, platinum can do, and experiments showed that calcium was able to occlude a considerable amount of hydrogen. The more extensive observations independently made by Dr. Ohmann, and recently published in the *Berichte* of the German Chemical Society, suggest that in some cases, at all events, the explosion of calcium is due to a vaporisation of the metal near the edge, where the pressure is greatest, and a combination of the vapour with the atmospheric oxygen. If the calcium be hammered in oxygen the flash produced is much more brilliant, while if the metal be struck with a rounded hammer only a faint light is observed, for then there is less vaporisation at the edges. When several slight blows are given in succession there is an accumulation of heat, and eventually a gentle blow may then cause an explosion. Similar phenomena occur in the case of other metals. Sodium hammered on an anvil gives out a bright flash, and small yellow flames are sometimes produced. Potassium gives marked effects with almost every stroke of the hammer, small violet flames with clouds of strong-smelling vapours being formed, while small incandescent fragments may be split off by sharp blows. Lithium also gives brilliant flashes, frequently accompanied by a report and by sparks. The light emitted is much more intense than in the case of potassium. Powdered aluminium and magnesium only give small sparks, and do not explode. Of the non-metallic elements tried by Dr. Ohmann only phosphorus gave a positive result. It was expected that the blow would cause the phosphorus to ignite, but instead of this it was flattened out into a dough-like mass and emitted sparks.

Liquid Nitrogen.

Dr. H. Erdmann has recently investigated the properties of liquid nitrogen more fully than had previously been done. It is a clear, mobile, colourless liquid which differs greatly from liquid air in its physical properties. It produces a much greater lowering of temperature on evaporation, and is thus a good cooling agent. When it is poured over a bulb of oxygen the gas condenses in bluish drops on the inside of the glass. Liquid nitrogen is a good solvent for liquids that boil at a low temperature. It mixes readily with liquid ozone. As a chemical agent it is as indifferent as gaseous nitrogen, and burning magnesium wire plunged into it is immediately extinguished. When poured over metallic calcium, however, it enters into combination to form calcium nitride, which yields ammonia on treatment with water.

The Dangers of Tinned Meat.

The exposure of disgusting practices in connection with tinned meat has naturally frightened many a consumer, although under proper supervision this method of preserving

flesh should be quite free from objection. It is, therefore, of special interest at the present time to see what risks are run in eating such meat. It is asserted that the flesh of animals suffering from tuberculosis and other diseases is frequently used in these preparations. Although in the case of tuberculosis the practice is very objectionable, there would seem to be little risk of the flesh of an uninfected part of the animal conveying the disease to man, and even when the disease was general thorough cooking would destroy the bacilli and probably the toxic substances produced by them. There is, however, much more danger in eating the flesh of animals infected with the various bacteria that produce septicæmia, since their toxic products are only partially destroyed by heat. The flesh of animals suffering from anthrax, malignant œdema, and chicken pox is also dangerous whether in the raw or cooked condition. But this danger is one to which the consumer of fresh meat is also liable, whenever the system of inspection is defective. A greater danger in tinned meats than the presence of disease organisms and their products is that flesh containing putrefactive products may have been used. Wholesale putrefaction of the contents of the tin would, of course, make itself known when the tin was opened, but this would not be the case if flesh in a state of incipient decomposition had been used, for the sterilising process would have arrested any further change. The meat in the tin might, in fact, be absolutely free from bacteria, and yet be poisonous. The products formed by the bacteria are even more dangerous than the organisms themselves. Thus, in Germany, there have been wide-spread epidemics of what is known as *botulism*, a severe form of poisoning through eating raw or imperfectly cooked sausages. These have been found to be due to a definite toxine produced by *Bacillus botulinus* in flesh from which air is partially excluded. This toxine has also been found in poisonous hams, but as it is destroyed by heat it is not likely to occur in tinned meat that has been properly sterilised. But there are numerous other bacterial products—the ptomaines—which, unlike true toxines, are not destroyed by heat, and it is to one or more of these that most of the not very frequent cases of poisoning by tinned meat can be attributed. Many of them are simple substituted ammonias, such as *putrescine*, $C_{12}H_{12}N_2$, while others contain oxygen. *Cadaverine*, *neuridine*, and *saprine* are diamines, allied to *putrescine*, and, like it, are only slightly poisonous, but *methyl-guanidine*, $C_2H_7N_3$, which has been isolated from decomposing horse flesh and beef, is extremely toxic, and when injected into a small animal causes death within 20 minutes. *Neurine*, $C_5H_{13}NO_3$, a ptomaine formed on the fifth or sixth day of putrefaction, is also very poisonous, while *muscarine*, $C_5H_{15}NO_3$, from decomposed fish, is still more deadly. It appears to be largely a matter of time whether or no a particular ptomaine is produced among the continually changing products formed by putrefactive bacteria, and hence if there be truth in the report of unclean conditions in the factories it is by no means unlikely that particles of very dangerous flesh may become mixed with the fresh meat in the canning process. This may be regarded as the chief danger of tinned meat, and the only means of guarding against it is a thorough and systematic inspection of the factories, so as to insure absolute cleanliness.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

About Dew-Ponds.

IN reviewing a book in the May number of "KNOWLEDGE" on neolithic dew-ponds and cattle-tracks, I referred to the statement made by Dr. Hubbard that there was a wandering band of men who were going about England, in whom was vested the secret of making these ponds. The object they aimed at was to cause an artificial precipitation of dew by a combination of thatch and puddle. It would be interesting to know more of the people who are said to be occupied in this pursuit. At a paper read at the meeting of the S.E. Union of Scientific Societies at Eastbourne last month, Mr. Jenner referred to these ponds, and also to a builder at Alfriston who was stated to be engaged in making them. In visiting this maker of ponds I found that all that he had made had merely received a foundation of concrete, whether they were situated on high or on low ground. A dew-pond is a definite kind of pond, and must be regarded as quite apart from those which are merely made with an impervious bottom, and depend on rain and runnels for their supply. It is obvious that a pond situated on the top of a chalk down may receive a slight addition to its sum from the rainfall upon its surface, but natural runnels to feed it would be impossible upon so pervious a soil. Such would not be entitled to be called dew-ponds, unless it were known that the supply was attributable to an artificially-induced precipitation of dew.

Ponds on Worms Heath.

In "Neolithic Man in North-East Surrey," by W. Johnson and W. Wright, a cheaper re-issue of which we are glad to welcome, mention is made of a dew-pond on Worms Heath, and the suggestion is made that by puddling the bottom, a pond was formed in the depression of a neolithic hut-circle. I am not sure from the context that one can be quite satisfied that this is a true dew-pond, since with the removal of the shingle the clay bottom has, in some of the gravel pits on Worms Heath, resulted in a good deal of water lying stagnant there, and this pond may, perhaps, have formed spontaneously. On page 47 of the same book the authors refer to the strange sight seen in some parts of carts being sent up hill to obtain water from dew-ponds, or mist-ponds as they have often been called. It may, perhaps, be suggested that the immortal Jack and Jill obtained their supply from a dew-pond, since they were compelled to go "up the hill." Gilbert White makes some interesting remarks concerning one which was situated on Selborne Down, 300 feet above his house. It was never above 3 feet deep in the middle, nor more than 30 feet in diameter, yet it was never known to fail, though it afforded "drink for three or four hundred sheep, and at least twenty head of cattle beside." Unfortunately this pond when last I visited Selborne had at length become dry.

The Connection of Volcanic Action with Earthquakes.

In considering the many earthquakes shocks, small and large, which are constantly adding their quota to the tremulous condition of the globe, one cannot but be struck by the ignorance in which we still remain as to the constitution of the earth's interior whence such shocks originate. Certain lines of weakness, as they are called, present themselves on the surface, and these are marked by active volcanoes, and for the most part they appear in those parts where, so far as we can judge, the crust has been weakened by denudation, or where the fall is very rapid from a great height to a great depth, as on the Pacific slope of America. Earth tremors are closely connected with invisible intrusive volcanic action, and this results from contraction brought about by the cooling of the globe. It is not easy to imagine volcanic action without shocks, but on the other hand shocks may be felt, the connection of which with volcanic action is not so apparent.

Whence the Lava may be Derived.

For the supply of eruptions Mr. O. Fisher imagined a liquid zone at a depth of about 30 miles, although its depth would not be constant. A chilling at the surface due to removal of material by denudation would result in a depression of the boundary limit, whilst on the other hand, a deposition of some thousands of feet of sediment would cause it to be raised nearer to the surface. By this means we should have what has been called the "melting off of the roots of mountains," and this would, in a way, account for the smallness of the deviation of the plumb line when tested with a mountain mass. When, too, one sees the enormous foldings and contortions of palæozoic and archæan rocks, one may well ask how such foldings would be possible, unless the strata were in touch with some fluid mass yielding to the superincumbent mass and its movements. Some of the overthrusts, of enormous extent, with which we are familiar in pre-Cambrian rocks, almost baffle one if one is to consider them as having taken place while the rock was as solid as we now see it. Grant for a moment

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that it became partially involved in a great melting process, consequent on the rise of a heated liquid zone, and the foldings assume a more-to-be-expected aspect. In the rise of such a zone, strata would not necessarily lose its stratified form, although it would become of a plastic consistency. All kinds of gradations would afterwards appear in such rocks when they again cooled, and these would give rise to those metamorphosed rocks which it is impossible to classify either as igneous or sedimentary.

Why Lava Rises in a Volcano.

Occassionally portions of sedimentary rocks are erupted from a volcano, but with these very occasional exceptions the lava, scoriæ, &c., which are erupted, and those intrusive rocks which do not reach the surface, may be held to represent part of the original, unaltered, material of the globe. Water plays the part of the explosive agent, and in later stages may assist in the welling of the material up the volcanic neck, after a rupture has been made, and a weak spot has thus been discovered. Different kinds of igneous rocks may be due to an actual stratified arrangement of molten material brought about by differences in specific gravity, at some time subsequent to the original condensation of the globe. There must, however, be some stress or strain to produce the necessary pressure or squeezing power for the upward flow, and no cause has so far been discovered other than that furnished by the secular cooling of the planet.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Jackass Penguins on Dassen Island.

AT the last meeting of the British Ornithologists' Club, Mr. Meade Waldo—who with Mr. M. J. Nicoll accompanied Lord Crawford on his winter cruise in his yacht the "Valhalla" in the capacity of naturalist—gave a most interesting account of the vast breeding colony of the Jackass Penquin on Dassen Island off the Cape of Good Hope, and commented on their extraordinary tameness. Though this colony was estimated to contain about 40,000 birds, it would seem that its ultimate extinction is within a measurable distance, since the eggs of these birds are transported annually in enormous quantities to the mainland.

Cape Cormorants were also breeding here in thousands; but they are carefully protected for the sake of the guano. On this account the presence of Sacred Ibises in their midst is regarded by owners of the island as objectionable, since they prey, or are believed to prey, on the young Cormorants. They are also said to live on the food brought by the Cormorants for their young, though how this is obtained was not apparent.

Migration of Swifts.

Colonel Yerbury at the meeting just referred to called attention to the enormous flocks of Swifts and Swallows which gather at Torcross in South Devon on their southerly migration. From August 5 onwards, for about a fortnight, Swifts are to be seen here in hundreds, and after their departure Swallows assemble here in thousands.

We draw the attention of our readers to this spot, since those interested in migration will probably find a rare opportunity of adding to our knowledge of this mysterious instinct, by a stay in this neighbourhood.

Curious Nesting Place of a Goosander.

Herr Zollikofer in a recent number of the *Schweizerische Blätter für Ornithologie* describes a case of a Goosander which nested in a hole in the roof or tower of a manor house at Werderberg. The height of the tower is 100 feet, and the young were in due time brought down to the ground in safety by the parent—it is supposed in her bill.

Blue-Throated Warbler in Norfolk.

The Rev. M. C. H. Bird writes to the *Field*, May 26, to say that he saw, several times during the 16th-17th May, a Blue-throated Warbler in the neighbourhood of Hickling Broad. As this bird, during the autumn at any rate, is fairly common during certain years in parts of Norfolk, it is possible that, if unmolested, spring migrants may be induced to breed here.

Pallas's Sand-Grouse in East Lothian.

According to a note by Mr. C. S. Chambers in the *Field*, June 2, a flock of six Pallas's Sand-Grouse (*Syrrhaptes paradoxus*) was flushed by him when playing golf over well-known links in East Lothian. There seems no reason to doubt the accuracy of this record, especially after the description of the birds which supplements this note. They would appear to have been frequenting this ground for some time, and to have been seen on several occasions by one of the "caddies."

Fire-Crest Nesting in Skye.

The *Field*, June 16, contains a note by the Rev. D. De Mackinnon on the nesting of the Fire-crested Wren in Skye. On May 19 the writer saw a bird of this species sitting on her nest near Portree, and since then it seems three other nests have also been found. The "hen bird being very tame every opportunity was afforded of observing her on the nest." But for this assurance we should have felt inclined to believe that the Goldcrest had been mistaken for its rarer ally. And even now we cannot resist a suspicion that some mistake may after all have been made.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

On Japanese Mathematics.

THE following is from a paper by Professor Harzer, read last year before the Mathematical and Physical Section of the British Association, the Annual Report of which has just been issued:—"Concerning the Japanese numerical value of π, that is to say of the ratio of the circumference of the circle to its diameter, we have knowledge of the fraction 79/25, about the year 1627. On expressing this value in the decimal system of numbers, in use in Japan since olden times, the first two places are right. To the second half of the 17th century belong decimal values of the precision of 9 and 10 places. About 1709, there is to be found the famous fraction, 355/113, right to 7 places, and about 1722 and 1739, the precision increases to 42 and 51 correct places. Moreover, about 1766, the two common fractions

$$\frac{5419351}{1725033} \quad \text{and} \quad \frac{428224593349304}{136308121570117}$$

were known, representing π with astonishing precision to 12 and 30 places; and already about 1760 there exists the value, 98548/9985, for π^2 which is exact to 9 places."

The Black Spots in thin Liquid Films.

It is generally asserted that very thin films behave as perfectly transparent bodies, that is, that all the light is transmitted, and in consequence none is reflected. But Dr. Johannott has shown that there is more than one "black." The first found varied in thickness between 40 $\mu\mu$ and 12 $\mu\mu$. The first black was found to break naturally into the other when the atmosphere was incompletely saturated. With a thoroughly enclosed film, it was necessary to heat the system in order to form the second black film, which had apparently a constant thickness of 6 $\mu\mu$ in all cases.

Recently (*Philosophical Magazine*, June, 1906), he has discovered that great changes in the character of these films could be produced by changing the pressure on the atmosphere surrounding the films. A sudden increase in the pressure was accompanied by a rapid thinning of the film· while on the other hand a sudden diminution of the

pressure was accompanied by a corresponding rapid increase in the thickness. On subjecting the first black film to sudden increases in pressure, it was possible to convert it quickly into a second black; if then the pressure was suddenly diminished, the second black became a first black. In many cases it was possible to continue this thickening until the film showed the yellow of the first order. These changes are attributed to the heating (or cooling) produced by adiabatic compression (or expansion). The heating produced by compression is accompanied by an increased vapour pressure, and consequently evaporation takes place from the surface of the film; while on the other hand adiabatic expansion causes cooling and condensation on the film. Measurements of surface tension show that there is no discontinuity in the surface tension corresponding to the discontinuity in the thickness at the junction between the two black films. When the second black is obtained by slightly increasing the pressure, it appears as small, perfectly round, black spots in the first black film, which expand to replace the first black as the pressure is increased. If then, the pressure be slightly lessened, perfectly round spots of the first black will appear in the film of the second black.

The solution was made in the following manner:—7 grams of oleic acid (refined) and 2 grams of caustic soda are thoroughly boiled in about 100 c.c. of distilled water. This gives about 7.5 grams of oleate of soda, which is diluted to about 50 of water to 1 of soda, and again boiled. An excess of acid is not harmful, while an excess of soda is decidedly so.

The Effect of Sound on Water Jets.

A problem which has been the subject of much discussion is the external reality (or otherwise) of difference-tones. These notes have a pitch which is the difference of the pitches of two sources of sound, which are acting together, and the question in dispute is whether these are produced externally to the ear or are due to the mechanism of the ear itself. Some experiments bearing upon this question have recently been made by Mr. Belas, as a development of experiments of Professor W. F. Barrett. When a jet of water falls upon a membrane while a tuning fork is sounding in contact with the support of the jet, it excites a sound of the same pitch in the membrane, owing to the jet being broken into drops at intervals corresponding to the frequency of the fork. When two forks of pitches 384 and 512 vibrations per second influence the jet, the note given by the membrane has a pitch of 128, that is, two octaves below the higher fork. This effect is produced even when the notes of the tuning forks themselves are nearly inaudible. When instantaneous photographs of the jet are obtained, with each, and with both the forks sounding, the spacing of the drops corresponds with the separate pitches and with the difference-tones respectively. Now, the peculiarity of this experiment consists in that the difference-tone is heard even though the generating tones have disappeared. This then, seems to be a case in which the explanation given by Helmholtz cannot possibly be true. Helmholtz considered that they are in all cases produced only when the generating tones are intense, and are indeed due to the failure of the law of simple proportionality between force and displacement. The explanation given by the authors is more in accordance with the original explanation of Dr. Young. When two notes are of different pitch there are moments at equal intervals at which the resultant amplitude of vibration is greatest, *i.e.*, whenever both notes are in the same phase. The number of such events per second is equal to the frequency of the difference-tone; and it seems possible that the ear picks out these rapidly recurring, intense sounds, neglecting those which are feeble in comparison; and, if they recur sufficiently rapidly, interprets them as a musical note. An analogy of the action has been given by Professor Poynting. "Suppose a reservoir is at the sea-shore, just below the level of the highest spring-tide, and with some contrivance for emptying it slowly. Then it will fill once a fortnight, and its rise and fall will have a frequency equal to the difference in frequencies of the solar and lunar tides. Its oscillations will, of course, not be harmonic, but its chief vibration will be fortnightly."

ZOOLOGICAL.

By R. LYDEKKER.

Butterfly Swarms

THE April number of *Spolia Zeylanica* (of which the Editor has received a copy) contains an interesting account, by Mr. E. E. Green, of the enormous swarms of white and yellow butterflies which make their appearance every spring and autumn in Ceylon. In a space bounded by two points 30 feet apart and 12 feet from the ground it was calculated that about 150 butterflies passed, on an average, every minute. From this it was estimated that the number of butterflies passing in one direction between two points a mile apart and 12 feet from the ground would be 26,400 per minute, 1,580,000 per hour, and 6,336,000 between the hours of 11 a.m. and 3 p.m. on one day alone.

The Cairo "Zoo."

From the report for last year (of which a copy was sent to the Editor) it is satisfactory to learn that the Zoological Gardens at Giza, near Cairo, under the superintendence of Captain Stanley Flower, continue to make satisfactory progress, despite some losses from unfavourable weather.

Okapi for the British Museum

Captain Gosling, now on the Congo frontier, has already sent to the Natural History Branch of the British Museum a complete skin of the Nigerian giraffe, as well as specimens of many other mammals, and we now learn that he and his companion, Captain Alexander, have succeeded in procuring an okapi skin for the national collection. These two explorers seem to have come into very close contact with the animal, and have furnished some important information with regard to its habits; but the actual trapping was accomplished by a Portuguese collector accompanying the expedition.

Some New Mammals.

Mr. O. Thomas, of the British Museum, has recently been enabled to describe quite a number of new genera of small mammals. Among the more recent additions to the list is a mouse from Persia, for which the name *Calomyscus* has been proposed; this species being of special interest on account of the fact that it is totally unlike all other Old World mice and near akin to North American types, more especially *Peromyscus*. A second novelty is a new genus (*Platymops*) of free-tailed bats from North-East Africa, this bat being distinguished from its relatives, the mastiff-bats (*Molossus*), by the absence of wrinkles in the lips and the curiously flattened head. Here, too, may be appropriately noticed the description by Mr. R. B. Kinnear of a new race of British field-mouse (*Mus sylvaticus fridaviensis*) from Fair Island, south of the Shetlands.

Papers Read.

At the meeting of the Zoological Society held on May 1, the Hon. Walter Rothschild read a supplemental paper on gorillas and chimpanzis, at the same time exhibiting a splendid series of specimens mounted for his museum at Tring. All the gorillas were referred to a single species, with several sub-species, the typical race being represented by a dark-headed and a red-headed phase. Australian mammals formed the subject of a paper by Mr. O. Thomas, while Mr. F. E. Beddard contributed information with regard to the anatomy of snakes. Mr. H. J. Elwes, Sir George Hampson, and Mr. J. H. Durrant severally read papers on the butterflies and moths collected during the recent expedition to Tibet. At the meeting of the same body on May 15 Mr. Thomas read a further paper on Australian mammals, while Mr. R. I. Pocock discussed the breeding habits of certain monkeys in the Society's menagerie. On the same occasion Mr. J. N. Halbert described water-mites from Lake Nyasa, Messrs. Benham and Dunbar contributed notes on the skull of a ribband fish, Dr. von Linstow discussed hair-worms from Korea, while Mr. G. A. Boulenger communicated an account of certain new reptiles from Uganda.

XUM

The Artificial Generation of Life.*

By GEH. RATH PROF. DR. W. ROUX.

[*With a note by J. Butler Burke, M.A. (Camb. & Dubl.)*]

(Reprinted from the "Umschau," 1906, No. 8, the weekly journal of the work and progress of the combined departments of Science and Technical Knowledge (Frankfort a./M., H. Bechhold).

THE political newspapers and popular science journals are publishing accounts of the artificial generation of life and exciting universal amazement amongst their readers. The element of amazement arises, however, mainly from the interpretation put upon the matter by the imagination of the writers of these accounts; the experimenters themselves speak with considerably greater caution.

According to a communication in the English periodical *Nature*, No. 1,856, May 25, 1905, Mr. John Butler Burke sterilised some gelatine and placed it in a small tube with radium salt. After twenty-four hours there appeared on the surface of the gelatine a peculiar culture-like growth which gradually made its way downwards into the gelatine. When examined under a microscope a distinct growth was apparent; this was followed by subdivision of the circular bodies when they had reached a certain size, viz., 0.0003 mm., and they often took a rosette-like arrangement. Mr. Burke thinks the name *Radiobes* (Radium organisms) might be given to these bodies. Professor Sims Woodhead asserted that their resemblance to bacteria is only an apparent one. He showed that the forms, when removed to fresh gelatine, increase still further in size, and that on heating the cultures till the gelatine dissolves they disappear, but become visible again after a few days.

Mr. Littlefield is stated to have obtained a similar result by quite a different process. To a 33 per cent. solution of common salt there was added the same volume of 90 per cent. alcohol. Small quantities of this mixture were placed in watch-glasses, a little ammonia was added, and the whole covered with a bell-glass. In half an hour drops were visible on a slide with the aid of a microscope. Crystals of common salt settled out first, then crystals from which emerged small oval or round forms which are alleged to be living organisms, since they grow, and, like amœbæ, send out moving processes.

But, assuming that the account of the directly observed results of these two experiments is absolutely correct, the conclusion drawn from them, that forms corresponding to living organisms have been obtained, is by no means justified.

These unjustifiable conclusions arise from the want of a *complete definition of life in its simplest form.* A quarter of a century ago I formulated such a definition† of living organisms on the ground of their peculiar property of self-preservation and the persistence of their species through the ages, notwithstanding alteration of material and environment, and I have recently more completely established this definition.*

It is impossible to make a purely chemical definition of life, such as has long been sought, because life is intimately bound up with those physical aspects which are not merely the result of the chemical constitution, but rest also on a special physical structure. The definition of life can at present only be made on the basis of the *activities* of the living organisms, so far as we know them. Such organisms, at their simplest, are natural bodies which (1) absorb foreign materials into themselves (*absorption*), and (2) convert them into substance resembling themselves, assimilate them (*assimilation*); (3) change themselves by means of processes taking place within themselves† (*Dissimilation, e.g.*, consumption of albumen, fat, &c.), or, on the other hand, may remain entirely or almost entirely unchanged (4) by spontaneous secretion of the altered material (secretion of carbonic acid, urea, &c., in animals, of oxygen, &c., in plants), and (5) by *spontaneous repair* through absorption and assimilation of food; and (6) may grow by over-compensation in the repair of the used-up material (*spontaneous growth*); further, (7) from causes lying chiefly in themselves they are able to move themselves (*spontaneous movement, reflex movement*), and are also able (8) to subdivide themselves (*spontaneous subdivision, spontaneous multiplication*), and (9) to transmit their characters entire to the organisms which spring from them (*transmission*). It remains to urge emphatically that *all* these long-known activities belong together, and that they are in their own way *fixed, determined, in the organisms*, even though their perfection is often dependent on external factors, and though their activities are somewhat modified by external influences. The *sum* of these activities is what determines the character of the living organism, as well as the *highly developed faculty of self-preservation.* Living organisms are primarily concerned with the renewal and preservation of their species, and when food is present they take what is necessary to maintain their own existence.

Forms exhibiting the activities here enumerated would certainly be accepted as living organisms. But there is yet another essential property of all forms of life, even the lowest: (10) *the spontaneous regulation of the exercise of all specific activities;* the more, for instance, they are deprived of food, the greater is their desire for it; when a certain quantity has been absorbed the capacity for absorption is diminished; the more foreign materials have been formed, the more possible is it to secrete them, &c. By means of this power of regulating function, which, of course, is not without its limits, the faculty of self-preservation, and with it the *persistence* of the organisms, is substantially increased; indeed, when changes occur in external relations, this power is indispensably necessary in order to prolong existence. We must, therefore, regard the *spontaneous regulation of function as a further "primary property"*

* Translated by Miss E. Slater.

† "The Struggle of the Parts in the Organism," Leipzig, 1881. Also in "Collected Treatises on the Mechanics of Development," Vol. I., p. 387. 1895.

* "Suggestions on the Mechanics of Development: I. The Mechanics of Development, a new Branch of Biological Science," p. 105. Leipzig, 1905.

† In the lower organisms dissimilation is not an absolute and continuous process as it is amongst warm-blooded animals, but it is essentially conditioned by the using up of energy and the wear and tear of the machinery through action. Many experiments made on cold-blooded animals, as for instance by drying and freezing, indicate complete suspension of metabolic changes. The continuous destructive decomposition of the warm-blooded animals, however, assists in self-preservation, since but for the maintenance of a higher temperature their machinery would not perform its functions and they would consequently be incapable of self-preservation.

of the living organism. With it is associated also the *power of adaptation* to changing external relations (for instance, to change of the accessible food supply) and, amongst higher forms, to changes of climate, to changes of habitat, to or from a flat or a mountainous region; that is, to the consequent alteration in the mode of life and in the various instinctive activities. It is only by means of this power of adaptation that self-preservation becomes possible in the face of changes in these relations.

Since all this adaptability (conformability), as it is called, in the activities of the organisms, serves only to prolong their existence, it is more appropriate to speak of the *persistence* than of the *adaptability of the organisms*, and to speak of their *recuperative and progressive activities* rather than of their adaptable activities, a suggestion (v. No. 1, p. 214) accepted by various authors (*e.g.*, Ostwald) and attacked by others (*e.g.*, Ed. v. Hartmann).

No form which does not exhibit *all* these activities can be described as even the lowest kind of living organism. But where these exist we need not concern ourselves with their origin or special chemical and physical nature. It is, however, essential that such forms should, in addition, possess special properties in order to continue their existence on the earth. They must, for instance, be insoluble in water, since they would otherwise be liable to be destroyed by the frequent rains, and so would not be able to persist through the centuries nor reach any further stage of development.

The higher organisms possess, in addition, many other properties, as, for instance, the power of assuming various forms (the *spontaneous development* of all characteristics of class, genus, species, &c.), and the manifold psychological activities, all of which are determined according to the substance of the organisms, but do not now concern us. To emphasise once more the essential point: the organisms participate in the renewal and preservation of all their special "typical" mechanisms of self-determination and self-preservation, as well as in the production of the outer factors which are determined from within; that is, which depend on their own physico-chemical structure. "Typical" in this definition is a more strictly limiting conception than "normal," which has hitherto been adopted *

Turning now from what is known to the experiments of which mention has been made, let us ask whether the forms produced in each of the two experiments present *all* these primary activities of life.

Of Burke's forms it is only asserted that they grow and subdivide. We must, in the first place, enquire whether this growth is "spontaneous growth"; in other words, whether it takes place in accordance with the characteristic growth of the organisms by means of new living substance formed in and by the organism itself, by assimilation of other materials *within* the organism, and not, like crystal growths, consisting of accretion of external materials surrounding it, even though these materials have been produced by the influence of the form itself, or whether it depends only on a propagation of this influence, like the propagation of warmth, or of diffusion.

In the second place we must ask whether the subdivision of the forms which has been observed is really *spontaneous subdivision*, and whether it takes place by means of influences which are determined *within* the organism in accordance with its nature. On this point nothing is said, but it may, perhaps, be the case. It may, however, be remarked that apparent subdivision takes place under many conditions. For instance, if we place a drop of alcohol on water, or a drop of oil on a solution of soda, the drop divides very quickly, and apparently spontaneously, into four parts; in reality, however, it is divided by the influence of the surface tension. Nor is the rosette-like arrangement peculiar to or characteristic only of living forms.

It will be seen at once that the main point is absent in the "observed" activities of Burke's forms; the proof, namely, that these activities correspond to the same activities in the lowest forms of life, that they are, in fact, "spontaneous activities" of the organisms. Besides, it is not probable that the mechanism of the two very different "organic" activities, assimilation and spontaneous subdivision, could be effected in so direct a manner; that is, by the direct energy of radium alone. But even if this were possible and had here taken place, these forms might still be considered as very interesting *preliminary stages* of life, as "probionts" (*Probionten*), but not as representing even the lowest forms of life, for they are without the activities of spontaneous dissimilation, of spontaneous secretion of changed materials, and of the spontaneous movement which is characteristic of living organisms, as well as of the spontaneous regulation of the performance of all activities.

Although the results of Littlefield's experiments are said to be different from those of Burke's, they are yet less inconclusive as to the artificial production of living forms. I have repeated these experiments and obtained results which in many ways apparently correspond to those described, but I ascribe to them a wholly different significance.

On the saturated ammoniacal solution of common salt in alcohol many small separate forms appeared moving hither and thither. But scraps of filaments arising from the impurity of the liquid floated about in the same direction, thus showing that the movements of the individual forms are not active, but passive, depending on the motion of the liquid. This, however, is by the way.

On the evaporating circumference of the drop, crystals separate, many of which have an area of liquid which has either been left on them or has possibly caught on them or has run over them. Thus we have forms which closely resemble cells. The liquid area may also have processes which, in consequence of further drying or of the altered surface tension, change their form and so present the appearance of slow amoeboid movement. But in all these it is only a question of forms arising from unequal moistening capacity of the glass, or its unequal surface and unequal surface tension. Anyone can produce similar forms to any extent by pouring water over a glass plate held obliquely; after most of the water has run away such forms are visible to the naked eye. If there are on the glass plate small unevennesses or dusty spots which are more easily moistened, the liquid collects on these parts, and on looking at it from above we again have the cell form with the nucleus in the middle and processes outwards, the latter of which change their form on further contraction or moistening. These well-known phenomena show that forms may be produced resembling amoebæ, but without their essential characteristics. Besides, the motion of amoebæ often depends on alteration of surface tension through external causes. But in the case of their spontaneously regulated movements the movement is produced from within and is definitely characterised.

Moreover, numerous pale yellow, very small and

* See No. 2, p. 182.

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round, or oval and flat disc-like forms were noticed, sometimes near these liquid area crystals, sometimes at a distance from them; these are probably Littlefield's organisms. To me they appeared to be residues left after evaporation, or deposits on dirty places on the plate. Perhaps they are partly produced like the flat drops which may be seen forming on the side of a vessel only partly filled with alcoholic liquid. Alcohol first rises invisibly, and gradually becomes visible on the sides; perhaps even a mist is deposited at a suitable temperature; in this way drops are formed which gradually increase in size; other drops are formed in the same way all about them, often appearing to issue from the earlier ones. These are well-known phenomena which, however, have nothing to do with specific organic "spontaneous growth." I have never seen any growth in the small pale forms which arise in great numbers as the evaporation proceeds, although I do not assert that such phenomena are impossible, for we know that instances of the kind may be found in similar artificial forms. The deposited drops just mentioned increase in size visibly; this, however, is not spontaneous growth, but passive growth, according to my definition. On large freshly-moistened glass surfaces division of the liquid used for moistening is frequently seen. This division is caused by retraction of the layer of liquid at some points of closer adhesion. It is not, however, spontaneous division, but is division "effectuated" and determined from *without* and influenced by the exact degree of surface tension, and is not connected (through qualitative bisection) with transmission.

We often can produce no direct, but only indirect evidence of assimilation and of the spontaneous growth which depends upon it, as also of spontaneous division, in the actual lowest forms of life. In order to adduce direct proofs of assimilation it would be necessary to watch for days together to see that materials differing in appearance were taken into the organism, that these did not accumulate in large masses different from the rest of the organism, but gradually disappeared. Even then assimilation is only indirectly proved by the fact that the vital force, instead of being reduced by taking in so much foreign material, is, on the contrary, increased, inasmuch as subdivision of the organisms goes on. If this subdivision has gone on through *several* generations, and has always resulted in forms resembling the original in shape and function, then we have a clear proof of spontaneous assimilation and of spontaneous division.

The actual lowest forms of life exist for the most part in aqueous fluid and prove by the fact of their remaining intact that they are not soluble in it. The artificial forms spoken of, on the contrary, are soluble in water; they are incapable of maintaining their existence in it, and in this respect also they are lower in the scale than living organisms.*

* While this paper was in the press there appeared (in the Karlsruhe Journal) another communication on the same subject giving an account of some interesting observations made in the Physical Institute at Karlsruhe under the famous physicist O. Lehmann; it was also widely circulated under the misleading title of "A New Physical Wonder." It gave an account of drops which form buds and divide, then assume a worm-like shape and afterwards separate into many parts. They crawl about like the Bütschli drops mentioned, but more quickly. These forms, which seem to be produced mainly by changes in surface-tension in a manner which makes them appear almost typically peculiar, must also be tested as to the degree of their resemblance to living forms by the analytic method of examining functions given above; and the nature of the forces in question must be narrowly scrutinized and compared with the influences which have produced organic phenomena of a similar kind. Perhaps here we shall come upon the beginning of that spontaneous division which is essentially determined from within.

We have recognised, then, on the one hand, that the artificially-produced forms are devoid of the primary activities essential to even the lowest forms of life; and on the other hand there is no proof that the activities observed depend on the power of spontaneous determination which is characteristic of living organisms, or that they are capable of that spontaneous regulation which alone would enable them to persist throughout many changes in external relations.

The *inadequacy of the definitions of the nature of life* formulated and promulgated by philosophers, naturalists, and even some physiologists, is ultimately responsible for the unwarranted interpretation of these forms as being actual organisms of the lowest stage. They think that what is needed is something simpler, more universal, more direct, than what I have given above, *the sum of widely differing* individual activities and the spontaneous regulation of these. Even if we leave out of count those authors who take the supernatural view and would have a "purposeful agent" (conscious First Cause) in the processes which result in life, yet we cannot disregard those who believe there could be a "simple" chemical process or a simple physical agency which could produce all these activities. According to this view a "simple" experiment might happen to produce this direct agent and thus suddenly give rise to forms of life. But there is a fundamental error in this view. The sum of the different activities described above alone indicates the minimum of actual life, and only those forms which possess this sum of activities reproduce similar forms; nor does this reproduction depend on the aid of a purposeful agent, but, the forms once in existence, reproduction depends only on the pre-determining tendencies inherent in their material basis.

Admitting all this, however, it would be vain to assert that in principle we could never artificially create the lowest forms of life, perhaps with very slightly developed spontaneous regulation. This, however, cannot be done by a single experiment, but only by a *methodical series of experiments* in which we must first endeavour to produce forms with one or a few primary individual activities. The insight which has been gained can be turned to account by combining the successful results already secured. Only thus shall we be able gradually to produce bodies which will combine all the *activities* indicated above *which are necessary for self-preservation by the processes of change in material corresponding to change in external circumstances*, and which will then continue and multiply. Forms possessing certain of these activities, spontaneous movement, spontaneous absorption, and spontaneous secretion of material, have already been artificially produced by Bütschli, Quincke, Rhumbler, and others. Spontaneous chemical assimilation, spontaneous growth, spontaneous secretion of altered material, and a certain amount of spontaneous regulation in assimilation and secretion are typically represented in the processes of assimilation by heat. Since, however, the other activities of self-preservation are absent in bodies thus produced, their power of persistence is inadequate. As soon as cold assimilation processes of a suitable nature (according to Pflüger, cyanide compounds) are employed, it is possible that high preliminary stages of life might be produced artificially by combining these with the processes for the last-named forms. Spontaneous division, spontaneous regulation, and "morphological assimilation," which presents special difficulties, would then follow. We shall then, perhaps, attain in the laboratory by observation and study in a relatively short time to what in nature has only arisen in the course of vast periods

of time as the result of a fortuitous concurrence of circumstances and of a spontaneous storing up of the forms capable of self-preservation through changes in material and thereby of "persistence."

If, then, it is certain that the above-mentioned experimenters * have produced no actual forms of life, even of the lowest order, and have not solved the problem of the artificial creation of life, and if this problem cannot be solved by one kind of experiment alone by reason of the number of primary life-activities necessary even to the lowest organism, we must assume that further research will be necessary in order to ascertain how far the various experiments of these writers are a new and valuable contribution towards the solving of this problem by the slow method insisted upon above, namely, the combining of artificially produced individual activities †.

* Including Charlton, Bastian, Stadelmann. (MS. note.)

† This is practically the argument used in *The Origin of Life* which which has just been published. I do not think however it is likely that we shall succeed in producing artificial forms of life which would correspond to the organic types existing naturally in nature. The probability of hitting on the exact conditions would be infinitesimally small. The most we can hope to do, as I have tried to show, is to imitate these by approximation. The artificial types, of course, do not satisfy all the conditions of *natural* life, it all depends, therefore, upon what we understand by life. If a scale of gradually increasing complexity can be established, from the supposed inanimate to admittedly animate nature, there should be no reason why we should confine the definition of life to natural types which have survived on account of their fitness for their surroundings. As a curve may approximate to its asymptote, so may artificial life approximate to natural life. But as the latter is the survival of countless generations, it is likewise to be expected that it should be more perfect than anything that by artificial means we should ever hope to obtain. I believe the subdivision of the radio organism proceeds from the interior, as I have tried to show, and that the growth is not by accretion, but by assimilation, as in the case of most organic crystals. They appear to assimilate sulphur and other substances from the medium in which they grow.

The Hedjaz Railway.

By P. L. SCLATER, D.Sc., F.R.S., F.R.G.S.

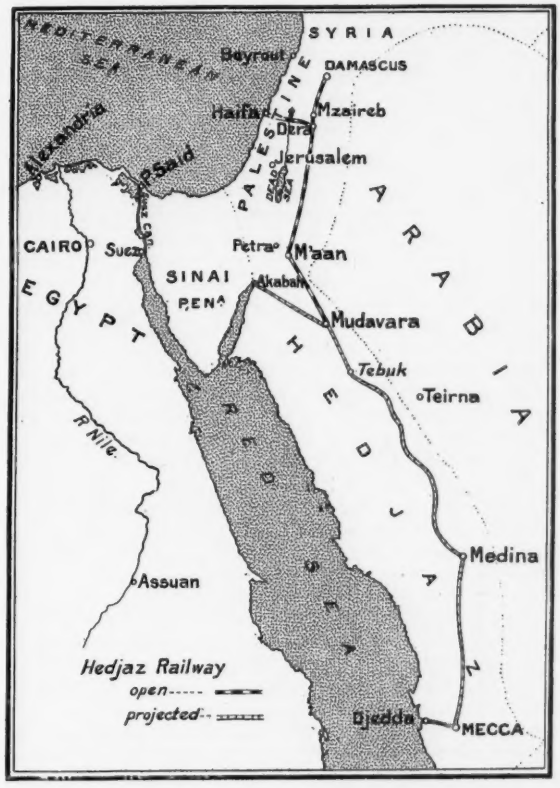
So little is known in Western Europe about the "Hedjaz Railway," which has been planned with the object of conveying Mahometan pilgrims direct to Medina and Mecca, and so saving them the danger and toil of a long overland journey, that some information on this rather mysterious subject may not prove unacceptable to the readers of "KNOWLEDGE."

Every Mussulman, as we know, is bound to undertake the pilgrimage to Mecca once in his life. And this pilgrimage properly begins at Damascus, where the holy tent is kept, although few pilgrims nowadays, except those who live in the district, go round by Damascus and perform the journey of 27 days overland, when they can be conveniently carried by steamer to Djedda, which is only 45 miles from the Holy City. The pilgrimage-caravan leaves Damascus with great ceremony once a year, at a period varying according to the Mohammedan calendar, and proceeds by the great pilgrim-route to Medina and Mecca.

The pilgrim-route (Derb-el-Hejji) is marked on most maps, and the railway, I believe, follows it very closely.

The exact inventor of the clever scheme of constructing a railway along the pilgrim-route from Damascus to Mecca is not known, but in Turkey is commonly supposed to have been the Commander of the Faithful himself; and this may well be the case, for the present Sultan is one of the most wary and capable of crowned heads, especially in matters relating to his own sovereignty. It is obvious that a railway made professedly to carry pilgrims would also be available to transport soldiers and military stores. And both these articles are much required in Central Arabia, where the continued and successful rebellion in Yemen has long been a source of great anxiety to the Sultan and his advisers.

However this may be, in May, 1900, it was announced in one of the official journals of the Turkish Empire that a railway was to be made from Damascus to Medina and Mecca, and the whole Mahometan world was invited to contribute every possible assistance to this pious work. This good news was greatly appreciated



by the Mahometan press, and was spread abroad not only over Turkey, Egypt, and Arabia, but throughout the eastern world where there were adherents of the Islamite faith. The great advantages of the new scheme, religious, political and economical, were duly dwelt on, and the Hedjaz Railway was lauded as of equal importance to the Suez Canal.

To commence the work six Mussulman engineers were assembled (not without some difficulty), and despatched to Damascus to make a preliminary survey, and it was agreed that all materials for the holy project should be supplied exclusively by Mahometan factories. Three new railway-battalions of soldiers, each a thousand strong, were raised to act as "navvies." But it was soon discovered that, though the Turks might be efficient as navvies, they could not make rails or build locomotives and trucks, and it was found necessary to go to Belgium and Germany for a supply

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of these requisites. It was also quickly shown that the native engineers were useless, and their places were taken by Europeans from Italy, France, and Poland. A German engineer, Herr Meisner, was placed at the head of the railway-corps.

Great efforts were made to raise the money required for this gigantic task. The Sultan set a good example by giving up a month of his civil list, amounting to 50,000 Turkish livres, and a tax of 10 per cent. on all salaries was levied in aid of the undertaking. Besides this, large donations were received from all parts of the Mussulman world, especially from India and Ceylon. Mirza Ali Bey, of Calcutta, sent a donation of £5,000 to the holy work, and promised further advances, and large sums were also received from Australia, Singapore, and Natal.

On September 1, 1901, being the 26th anniversary of the Sultan's succession, the first portion of the new line (about 20 kilometres, between Mzaireb and Dera) was opened with great ceremony. Other portions followed suit from time to time, and the main line from Damascus to M'aan, a place about half-way between the south end of the Dead Sea and the north end of the Gulf of Akabah (conveniently near to the famous ruins of Petra), was sufficiently finished to carry slow traffic about a year ago. The length of the line, as shown by the subjoined list of the stations (kindly supplied to me by Messrs. Thos. Cook and Son), is 465 kilometres. Since then (as we were informed by the correspondent of the *Times* at Constantinople in December last) the line has been carried on for a further length of 150 kilometres to Mudavara, and it has been determined to build a branch line either from that place or from M'aan to the head of the Gulf of Akabah.

But a still more important event in connection with the Hedjaz Railway now remains to be mentioned. To connect the great city of Damascus and the fertile country around it with the civilised world two railways were originally planned—a French line to start from Beyrout and cross the Lebanon and Antilebanon, and an English line commencing at Haifa and crossing the Jordan south of the Sea of Galilee. The northern (French) line was quickly carried out, and for some years has been the established route to Damascus. The southern (English) line, ill-provided with funds and not in favour at Constantinople, has never prospered, and only a few miles of it out of Haifa were ever opened. Abdul Hamid realised the situation, and after a long bargaining with the concessionnaires, succeeded in buying up the undertaking and completing it from Haifa to Dera, a station on the Damascus-Mecca line, 123 kilometres south of Damascus. The Sultan will thus be able when the whole project is completed, to ship his pilgrims (or soldiers!) at Haifa and run them straight to Medina and Mecca. This will not only save the passage of the Suez Canal, which, as being under Anglo-Egyptian control, is not favoured by the authorities at Constantinople even for pilgrims, but will also enable troops and arms to be sent to Central Arabia without any risk of their being stopped or delayed in Egypt.

I am not much in sympathy with the Turk and his ways, but in the case of the Hedjaz Railway I think he has done a good work and deserves success. It may probably be some years before the line is completed to Medina and Mecca (!), but in the meantime a country very little known and hitherto very difficult of access has been opened up, and Petra and many other ancient sites along the route which it traverses will be rendered comparatively easy of access. Messrs. Thos. Cook and Son inform me that they are making arrangements whereby travellers will be able to visit the wonderful ruins of Petra by the Hedjaz Railway from Damascus to M'aan during the next season in Palestine.

There can be no doubt that the recent occupation by the Turkish forces of one of the ports at the north end of the Gulf of Akabah which is now producing much friction between the Egyptian and Turkish Governments, is caused by the anxiety of the Sultan to find a suitable opening for the Hedjaz Railway on that Gulf. If this can be secured the Porte will be able to send its troops and stores into Central Arabia without going through the Suez Canal, which might be closed at any moment in case of war.

List of the stations on the Hedjaz Railway :—

	Distance from Damascus in Kilometres.
Kaaden esh Shereef (Damascus)	
El Kieweh	20.80
Deir Ali	30.50
El Miemiyeh	49.70
Jebab	62.60
Khubeb	69.10
Mabje	77.80
Shakra	84.50
Ezra (Zorca)	91.25
Kharbet el Karaly	106.10
Dera	123.00
(Junction with the line from Haifa)	
Nassib	135.35
Mifraka (Kelaat el Mefraak) ...	161.70
Kharbet es Samra	185.30
Zerka (Kelaat es Zerka) ...	202.75
Ammon	222.40
Kasr el Ala	234.05
Leben	243.50
Djira	259.70
Dekaa	279.15
Ez Zebib	295.70
Katranek	326.60
El Khassa (Kalatel Hassi) ...	378.25
Jeroof ed Derursh (Wadi Benna)	397.80
Aneiza	425.25
M'aan	465.00

Plants and Frost.

ACCORDING to Professor Wiegand, of Cornell University, it seems probably that frost causes the death of vegetation by causing the actual withdrawal of water to form ice *outside the cell*. The ice formation dries out the cells, and the plant suffers therefore from drought conditions. Every plant cell has its critical point, the withdrawal of water beyond which will cause the death of the cell, whether by ordinary evaporation or other means. It may be supposed that the delicate structure of the protoplasm necessary to constitute living matter can no longer sustain itself when too many molecules of water are removed from its support. In the great majority of plants this point lies so high that it is passed very soon after ice begins to form in the intercellular spaces. Hence the death of so many plants at this point. But other plant cells may be able to exist with so little water that a very low temperature is necessary before a sufficient quantity is abstracted to cause death. From some plants enough water cannot be abstracted by cold to kill them (many bacteria, it will be remembered, can endure the cold of liquid air). In rather dry tissues, as in some winter buds, a temperature twenty to thirty degrees below freezing may be required before the ice crystals can be seen in the tissue.

REVIEWS OF BOOKS.

ASTRONOMY.

Radcliffe Catalogue for 1900; of 1772 Stars, chiefly comprised within the zone 85° to 90° N.P.D. (Oxford, 1906, xxxvi. + 81; 15s. net).—This volume, published by order of the Radcliffe Trustees, under the direction of Dr. Rambaut, the Radcliffe observer, contains the results of ten years' meridian observations with the Radcliffe transit instrument, formerly used by Carrington. Of the years in question, 1894 to 1903, the first two were mainly devoted to finishing off the previous Radcliffe Catalogue for 1890, and the last to dotting the i's and crossing the t's of the present one. The quantity of observations, even if wholly confined to the seven remaining years, is not by any means large, but it should be borne in mind that the staff is small, and has much other work to do, and that serious interruptions were caused by the death of E. J. Stone in 1897, and the appointment of his successor, who was, perhaps, inclined to be too sceptical as to the value and validity of his predecessor's work. Most of the stars in the present catalogue are to be found within the zone 85° to 90°, N.P.D., and it also contains all the stars legitimately included in the Nautical Almanac Zodiacal List. (N.A., 1897.)

It might at first sight be thought that Dr. Rambaut's remark on the first page of the introduction, as to the number of stars in the catalogue, is a rather clumsy paraphrase of the possibly sarcastic statement, "The observations, *though few*, are good." The real meaning of the sentence is that the observers did not endeavour to work against time, as they might have been tempted to do. Alterations were made in the floor of the room to increase the stability of the instrument, and various other improvements introduced into the system, notably a chronograph. It is not clear that the substitution of a circular mercury trough for reflection observations of stars is an improvement, as the dimensions are not given. For nadir observations, where the advantage of a circular trough is less questionable, the old rectangular one is still in use. It seems obvious that unless the circular trough is very large, its use for low stars is a great mistake, and if low stars were not observed, is it not surprising that the R-D discordance should be regarded as unsatisfactory? Very few stars were observed for Colatitude, so that it is quite likely that all the catalogue comparisons at the end of the introduction are systematically affected. It appears certain for instance, that the comparison with *Greenwich, 1890*, from which Dr. Rambaut professes to cast doubt on the validity of the Greenwich R-D correction, is erroneous, since the adopted colatitude at Greenwich is affected by R-D, and this point, as well as the effect of substituting Pulkowa refractions for Bessel's, seems to have escaped the Radcliffe observer's notice. There is a description of the determination of pivot-errors by a method devised by Dr. Rambaut, founded on that of M. Hamy, of the Paris Observatory. There is also a defence of electric control for chronographs, which, however, is not satisfactory, as it assumes that there is no lag in the changing speed gear, and that the observations are all read in accurately by proportional scale, which, though desirable, is only attainable when the number of registered observations is comparatively small, or the computing staff large and not busy. Our readers must not infer that we are objecting to the electric control so much as to the defence of it. Several pages are devoted to a discussion of the division errors of the circle, which leave the impression of a great waste of time. Stone's errors being under suspicion, the observations on which they were founded were re-examined, without the light of the knowledge as to their relative value, which Stone undoubtedly possessed, but did not record, with the natural result that by giving equal weight to most of them, a different set of corrections was obtained, and the also natural result that the differences were slight. Whereupon, as the old corrections were already in use, no change was made. It is difficult to see what change could have been made without repeating the observations themselves, as it could hardly be Stone's powers of computing that were under suspicion. We can appreciate the determination not to waste more time by altering the corrections, better than we can appreciate the devoting of several pages of introduction to the account of the investigation. Very few of the fundamental stars seem to have been really well observed in N.P.D. Possibly it was in this one unfortunate direction that the observers were encouraged to save time. In one place, Dr. Rambaut says: "The results are of a high order of accuracy, as is shown by the tests which have been applied," *i.e.*, the probable error is small; in another place he says: "The smallness of the probable error corresponding to the zone 120° to 122°, is obviously *an accident, due to the small number of stars which it contains.*" Are we to infer that the probable error of a single observation *must* be zero, or that the probable errors of the catalogue are small because the stars are few? Nearly all the stars in the catalogue have been observed three times at least in each element. Among the very few exceptions, we notice Sirius with only two observations. It seems a pity such a star was included at all, if so few observations were made of it, especially as it involved corrections for orbital motion and parallax. Reference numbers are given for each star to Auwers' Bradley (1755); Lalande (1800); Weisse's Bessel (1), (1825); Albany, A. G. (1875); Radcliffe (1890); Greenwich (1890); and Bonn Durchmusterung (1855), and notes are added on magnitude and colour, and authorities given for the adopted proper motions. We have nothing but praise for the general style and appearance of the volume, which is similar to the Radcliffe 1890 Catalogue. It will be interesting to compare the results with other catalogues of the same epoch when they appear, a time which should be fast approaching.

BIOLOGY.

The Dynamics of Living Matter, by J. Loeb, Columbia University Zoological Series (New York and London, 1906; pp. xi. + 233, price 12s. 6d. net).—Two transcendental problems, observes the author, confront the biologist at the present day, namely, the artificial transformation of dead into living matter, and the artificial transformation of one species of animal or plant into another. As to the first problem it is certain that no one has yet witnessed such a transformation, but since we daily see animals and plants converting dead into living matter in their own tissues, and since chemical processes are essentially the same in living and in dead matter, Professor Loeb does not despair of the discovery of abiogenesis, and urges that this should be the goal of every biologist. Incidentally he raises the question whether death is a necessary outcome of development, and whether rejuvenation and the commencement of a new cycle are impossible. As to the second problem, this has undoubtedly been solved by de Vries's famous experiments of primulas, and, if plant-species can be artificially produced, why not animal species? The chemistry of living organisms, the general physical constitution of living matter, the more important physical manifestations of life, the influence and effects of electricity, heat, and light upon living matter, the phenomena of "heliotropism" (turning to the sun), the nature of fertilisation and regeneration processes form the subject of the various chapters (originally lectures) which go to form this thoroughly philosophical, and at the same time thoroughly practical, work, which cannot fail to raise the already high status of the series to which it belongs.

BOTANY.

Methods in Plant Histology, by C. J. Chamberlain, A.M., Edition II. (Fisher Unwin, 1906; 10s. 6d. net).—The first edition of this book, written by a teacher of botany connected with the University of Chicago, was very favourably received in this country on account of its sterling merit; the present edition embodies all the reliable laboratory methods that have been discovered during the interval of four years. The collection and preservation of material, very important features, and on which further research almost entirely depends, receive special attention. Methods of growing laboratory material are also clearly outlined. The almost endless variety of reagents and stains cata-

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logued by dealers are apt to bewilder the student, and lead to much loss of time and vexation of spirit. A careful perusal of the book under consideration will, however, clear away such difficulties, as only those materials that have proved most suitable for specific purposes are indicated. A special chapter is devoted to the comparatively new method of making permanent preparations in Venetian turpentine, which is stated to be much superior in results to the well-known glycerine method. The subjects indicated above occupy about one half of the book, the remainder being devoted to an introduction to the study of forms which, while serving for practice in microscopical technique, will also furnish the student with preparations including a general view of the structure of plants, ranging from the algæ up to the angiosperms. The book will well repay the time expended on a careful perusal by every teacher of botany, however much experienced.

A Text-Book of Botany; Part I., The Anatomy of Flowering Plants, by M. Yates (Whittaker and Co.; 2s. 6d. net).—The author has obviously yet to learn what anatomy means; the only attempt to deal with anatomy in the book defines "A Medullary Sheath, consisting of spirally-shaped vessels round it." The book consists in reality of a string of attempted definitions of the various organs of plants, illustrated by what, for want of a more expressive name, must be called figures. Up to the present, botanists have been reticent when pressed for a concise definition of a cone. Here, we are told that a cone "is a dehiscent, syncarpous fruit, of a conical form, the carpels are woody, and each bears a naked seed on its inner surface, *e.g.*, pine, larch." Notwithstanding the above, and many other original statements, we are informed in the preface that, "It is by no means meant to be a popular work, but is for the use of examination students, and those who wish to commence a serious study of botany," etc., etc. The one redeeming feature is the part played by the publisher.

GEOLOGY.

Geology: Earth's History, by T. C. Chamberlin and R. D. Salisbury; Vol. II., Genesis, Paleozoic; pp. 677, and index to Vol. II.; Vol. III., Mesozoic, Cenozoic; pp. 578, and index to Vols. I., II., and III. (John Murray, Albemarle Street, W.; price 21s. each net). The second and third volumes of this series have now come to hand, and the authors deserve hearty congratulation on the completion of their work. The volumes in every way maintain the excellence of the previous volume which we received. They are clearly printed, and abound in illustrations taken direct from Nature. The third volume commences with the stratigraphical geology of the Trias, and the succeeding formations are dealt with in successive chapters, terminating with the "Human or Present Period," which, in the authors' terminology, begins with the disappearance of the glacial period, so-called, although they are careful to show that even now 10 per cent. of the land-areas of North America then covered with ice still remain in a glaciated condition. How completely America has Americanised geology is shown by a number of sections which are included in the Appendix, and although wisely the old international terms for the main systems have been carefully retained, new titles for the sub-systems and minor formations have been necessary to describe local developments. It is noticed that the Oligocene is regarded as a sub-division of the Eocene, whereas in this country it has come to be regarded as clearly defined from the Eocene below or the Miocene above. With this exception the titles of the main formations remain as in the old country, although the Lower Cretaceous receives the synonym Comanchean, a title which is now coming to be well recognised at home. In reviewing the mass of information contained in the book, concentrated as it has been from many a source, one cannot but be struck by the immense amount of work which yet remains to be done in America in connection with Mesozoic formations, and hence the necessity in some cases of giving to them local names. The Glacial Period is dealt with with particular thoroughness, no less than 190 pages being devoted to it. The title is used as synonymous with Pleistocene, and although man was a witness to this period, the Human Period is regarded as a succeeding and separate period. We do not think this arrangement free from misunderstanding, and if the title were to be adopted in British classification we should like to see included in it all those strata which bear witness to man's existence. But seeing that geologists recognise the probability of his first appearance in Pliocene times, and this may in the course of time be pushed back even earlier, we would prefer that the older arrangement should remain, viz., Pleistocene and Recent as subordinate divisions of the Quaternary. However, in these matters there will always be differences of opinion, and they in no way detract from the estimation in which we regard the whole work. Insular geology must be avoided at all costs by insular geologists, and it is to be hoped that these books will soon be found in all geological libraries in our country.

PHYSICS.

Practical Physics (Bower and Satterly, University Tutorial Press; 4s. 6d.).—In this handbook, we have a series of admirably designed and explained exercises on practical physics. They are suited to matriculated students, but in many cases are such as could be performed at home. In the latter, care has been taken to make them such as can be performed at trifling cost, and yet all trivial experiments have been avoided. The language employed seems, as a rule, very concise and definite. We notice, however, the usual inconsistencies in the use of the terms weights and masses. In the instructions on weighing, the "weights" are sometimes called by that name, and are sometimes called "masses." For example, the *masses* are to be added in descending order, while the *weights* are to be replaced in the box. This looseness will undoubtedly cause confusion. On the whole, the confusion would be least if we boldly spoke of *masses* throughout, and described the process as *massing* a body. This is a small detail. We recommend the book strongly to anyone in search of a text-book.

Properties of Matter (C. J. L. Wagstaff, University Tutorial Press).—This refers to the more general properties of bodies, many of which are usually considered in a course of mechanics, and it seems to have been specially designed to suit the requirements of those who may be going in for their degree without pursuing a thorough course in mechanics. We do not wish to say anything that will encourage this, at any rate, when a student is a student of physics in the real sense. For botanists and zoologists who may be taking physics as one of their subjects, and who then wish to throw it aside, the book will no doubt prove very useful in giving a brief account of its subject. We regret to see it stated that the standard metre is the length of Borda's rod, and the kilogram is the mass of the lump of platinum, made by Borda, and kept in the Archives. These have long since been supplanted. We regret to see "whole pressure" defined without any warning that this quantity is no use. Is Reynolds' theory of matter now looked on with favour? We thought it was discredited.

THERAPEUTICS.

Unconscious Therapeutics; or The Personality of the Physician, by Alfred T. Schofield, M.D., second edition. (J. and A. Churchill; 5s. net.).—The author in his new edition has made important additions to the text, and re-written Chapter VI. Dr. Schofield, in his opening chapter, "The Mind in Therapeutics," makes the interesting observation that in cases of hysteria or neuromimesis, the patient's sufferings are real. He attributes the phenomena to the power of an unconscious mind in an abnormal condition, and not, as was once taught, to an unhealthy womb. In unmistakable language he warns the profession against the folly of treating the body and forgetting the mind; he puts implicit faith in the mental personality of the physician or surgeon acting on the unconscious mind of the patient

for the latter's good. To emphasise the power of mind over body, instances are given where medical men have succumbed to the very diseases which they have made their special life-study. These instances may be merely coincidences, or it may be that a certain disease was studied in particular, and dwelt upon mentally because the specialist himself was a victim to it; in any case, opinion leans to the belief that continuous concentration of thought on any one particular part of the body tends to its local malnutrition and eventual organic disease. Genius alone is of little avail unless accompanied by such necessary attributes to success as set forth by Dr. Schofield in his chapter, "The Personality of the Physician." Genius, as a matter of fact, is not an essential, for who cannot recall to memory names of many worthy and eminently successful disciples of Æscalapius, whose success in life followed from what they *were* more than from what they *knew*. There is much worldly wisdom in these pages, but let us hope that evil consequences, such as are portrayed as a possible resultant from a visit to a Harley Street consultant, are overdrawn. The plodding, careworn, weary, practitioner might scan the chapter on "The Secret of Success in Practice" with a fond hope that this secret is laid bare; he will find there apt quotations from, among others, Reynolds, Gull, and Treves, containing advice felicitously and loftily expressed, but the secret that still lies hidden defies the efforts of successful genius to define. The closing chapter chiefly consists in an exposure of quack methods and Christian Science remedies; it also eloquently pleads for the need of systematic study of "Unconscious Therapeutics" in our medical schools. That this will come in time is hardly in doubt, and when it does, the profession will be the more fully armed and equipped for war against quackery than it has been in the past. Dr. Schofield deserves the gratitude of his medical brethren for bringing this subject so prominently before them.

ZOOLOGY.

A Treatise on Zoology, edited by E. R. Lankester, Part V., Mollusca, by P. Pilseneer (London: A. and C. Black, 1906, pp. 355, illustrated).—The want of a thoroughly scientific and trustworthy work written in English on the Mollusca, which should embrace the results of continental research on this difficult but interesting group, has long been felt in this country. The want is supplied by the handsome volume before us, which is the work of Dr. Pilseneer, the greatest living authority on the group to which it is devoted. In securing such a writer the Editor is to be highly congratulated, as this has resulted in a volume which will long remain the standard on the subject. A good idea of the vast strides which have been made in our knowledge of the natural history of the group, and also of the difference between present and former methods of investigation and description, will be gained by contrasting the volume before us with Woodward's "Manual of the Mollusca," which was regarded as an excellent work in its day. The amateur must not expect that he will be able to assimilate all that is to be found in this volume, sentences like "the Mollusca are cœlomocœla with a distinct cœlom and hœmocœl," and "in the adult there are two cœlomic cavities, the pericardial cœlom and the true gonocœl or gonadial cavity" indicating that it is written by a specialist for advanced students and specialists. For these, despite the occurrence of such a forbidding name as "Prorhiphidoglossomorpha," it will doubtless prove all that is expected—and that is a great deal!

MISCELLANEOUS.

Martin's Tables, or "One Language in Commerce." By Alfred J. Martin. Fourth Edition. (London: T. Fisher Unwin, 1906, pp. 271; price 2s. 6d.)

At Kimberley last summer the reviewer was told that a truck-load of blue clay from the diamond mines contains on an average only about .4 of a carat. This statement did not convey much meaning at the time, but reference to this useful and handy book now shows that about 82 milligrams is the average yield per truck; that is 1-12th of a gram. The book serves two purposes, one to provide useful information of every kind about weights and measures generally, and the other to urge the compulsory adoption by Great Britain of the international metric system. The arguments in favour of the metric system are so well known and so forcible that there is no need to here repeat what every reasoning man knows and feels strongly about. It would not be too much to say that English conservatism in this matter is in some measurable position responsible for the back seat which England takes among the countries of the world in regard to recognition of exact science. It cannot be said that the same demand exists for a decimal coinage. Coinages of different countries are of the most varied description, but the majority possess one feature in common, namely, that their largest unit is inconveniently small for representing pounds and hundreds of pounds, and that this unit is divided into cents which are too small to conveniently represent sums expressed in pence. None of these coinages ought properly to be called decimal coinages. If the French had only adopted metric nomenclature in their coinage their case would have been a strong one. The decifranc, franc, decafranc, and hectofranc would be excellent monetary units for any country to adopt; the franc and centime are not satisfactory. Moreover, the shilling of the duodecimal system finds its way into France in the frequent occurrence of 1 fr. 25 in prices. And it must not be forgotten that if England is conservative in regard to weights and measures, English and Italian speaking people can *count* properly up to a hundred and upwards, and this is impossible in the languages of many civilised countries, *e.g.*, France and Germany.

Chance: A Comparison of Facts with the Theory of Probabilities. By Joseph Cohen (London: Charles and Edwin Leyton, pp. 48; price 2s. net).—What makes the average Britisher a gambler, both in his business and in his recreations, is his ignorance of the laws of probability. He speculates in the hopes of making a fortune, instead of devoting his attention to estimating the probability factor which often converts that fortune into an expectation of loss. It is important that some knowledge of the theory of probabilities should form a part of the most elementary education in order to check this absurd and injurious speculative tendency, and there can be no better way of making a start than by showing that the results of theory are borne out by actual experience. The author details the results of many thousands of trials made by tossing a coin and throwing dice, also with cards and Halma pieces, and he compares the numbers obtained by actual trial with those found by theory. The result gives an interesting idea of the percentage divergence which is to be anticipated when the number of trials is finite, and it is interesting to see how this divergence is small in the case of the more probable events, and becomes greater in the case of improbable ones. The book can be read by anyone, and requires no knowledge of mathematics.

The Anatomy of Knowledge; an Essay in Objective Logic, by C. E. Hooper (London: Watts and Co., 1906; pp. 226, price 3s. 6d. net).—The appearance of this excellent and thoughtful little work is opportune, for, as the author observes, it can scarcely be denied that many of our modern specialists and experts are in the position of persons who cannot see the wood for the trees, or, as it may be more aptly expressed, who cannot see the tree for the branch on which each happens to be sitting. *Quo vadis?* is, indeed, applicable to a large proportion of the scientific workers of the present day, and anything that tends to consolidate thought on the object and trend of the vast stores of knowledge that are now being accumulated, and as to the nature of knowledge itself, should accordingly receive a hearty welcome by all thinking minds. What is knowledge, what are the principal things of which we have knowledge, how do we know what we do now, what is the relation of knowledge to practical life, and how is it connected with religious belief? are some of the fundamental questions the author endeavours to answer. Although philosophy, which is really the subject of this work, is a study often supposed to be abstruse and unpractical, "it may yet prove to be the very fulcrum by means of which the power of enlightened human will is destined to effect a renovation of the world." The application of philosophical methods to endeavour to ascertain to what (if any) goal many of our scientific studies are leading us, is a crying and urgent necessity.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Royal Microscopical Society.

May 16, Dr. Dukinfield H. Scott, President, in the chair. Dr. Bernstein gave an account of some observations recently made on the parasites of malaria, and the phagocytic action of the polymorphonuclear leucocytes. The subject was illustrated by a large number of drawings on the blackboard, showing the result of examinations made at intervals of a few minutes during a period of five hours, upon the blood of a patient suffering from malarial fever. A crescent form of the parasite was seen to become engulfed by a leucocyte, in which it was soon surrounded by vacuoles and ultimately destroyed, only the pigment granules remaining, which were themselves afterwards approached, and absorbed by other leucocytes. The blood film was stained, and the preparation, showing the pigment granules in the polymorphonuclear leucocytes was exhibited under a microscope at the meeting. Mr. C. Beck exhibited and described a simple wave-length spectrometer, for the purpose of testing colour screens, designed by Mr. E. M. Nelson, in conjunction with Mr. J. W. Gordon. It consisted of a diffraction grating, a slit, a collimating lens, and an eye lens. Mr. Gordon had worked out a method of measuring wave-lengths by this instrument without any reference to tables, as shown by a diagram exhibited, the wave-lengths being read off in millionths of an inch. The President then referred to the annual exhibition of pond life, in giving which, the Fellows had been greatly assisted by Members of the Quekett Microscopical Club. Nearly 40 microscopes were upon the tables.

Quekett Microscopical Club.

On May 18, Mr. A. E. Smith gave an account of the three methods he employed in stereo-photomicrography. In the first described, an arrangement similar to a Waterhouse diaphragm, in a photographic lens, is fitted above the objective, the aperture being eccentric to the optical axis of the microscope. Photographs are taken first with the aperture on one side of the axis, and then with the aperture on the opposite side of the axis. In the second method, which is very effective, the object is tilted up on the right and on the left respectively, for the two photographs. The third method was to first photograph the object in the usual way, and then to shift it laterally, very slightly, of course, before taking the second photograph. A number of excellent stereograms obtained as above described were exhibited.

Mr. D. J. Scourfield, F.R.M.S., gave an account of "Mendel's Law, and its Relation to Microscopy." Mendel's work was done in 1865, but was lost sight of until 1900. Details of some of his experiments were given, and his success in framing a law of heredity was attributed to his method of fixing his attention upon pairs of characters without troubling about the hybrid as a whole. Mendel's law stated shortly, is that, when the germ-cells of hybrids are formed, half of them contain the factor for one of each pair of characters, and the other half the factor for the other character. This generalisation accounts not only for the facts brought forward by Mendel, but also for a very large range of additional cases recently investigated. After dealing with the relation of Mendelism to microscopy, and the possible utilisation of microscopic organisms, such as the *Entomostraca*, for experimental work, attention was directed to the necessity for the modification of certain current views on "pure" races, variation, and the origin of species, which follow the acceptance of Mendel's law.

Quekett Club Journal.

The half-yearly, April issue of the Journal of the Quekett Club contains several interesting papers which have been read before the Club, and briefly reported in "KNOWLEDGE." Amongst these is an account of Mr. E. J. Spitta's experiments on the compound eyes of insects, which lead him to suggest that the facets of the cornea are in reality nothing but minute holes, filled, possibly, with some non-refractive material, and forming in the eye what is known as "pin-hole images," which may consequently be well defined. The Journal also contains Mr. Spitta's Presidential Address on "The Relative Merits of the Long and Short Tube Microscopes," which, with the subsequent discussion, is, however, somewhat inconclusive; full particulars of Mr. Dollman's and Mr. Taverner's respective methods of making stereo-photo micrographs, with some excellent plates illustrating results; and other papers. The notices of new books again find a place in the Journal.

Injection for Fine Vessels.

P. Konascko successfully and easily injects the organs of small animals by the following procedure: When it is desired to inject, say, the portal system of the kidney of the frog, a canula is introduced into the vena cava inferior or the vena abdominalis anterior. These large vessels are then injected with warm, colourless gelatine. The organ is, of course, placed in a water bath during the injection. When the operation is completed, the preparation is removed and allowed to cool. It is now easy to insert a canula into the finer vessels, which are distended by the injection-mass. When the canula is fastened, the preparation is placed in warm water again. After an immersion of a few minutes, the gelatine is liquified, and then the injection-mass is easily syringed in.

Flagella of Tubercle Bacillus.

Mr. E. M. Nelson, who is well-known as one of our most experienced and careful microscopists, and who first demonstrated the beaded, or, as he now calls it, jointed, appearances of the stained tubercle bacillus in the same year as its discovery by Dr. Koch, namely, in 1882, has recently stated that he has observed this bacillus to be flagellated. In view of the generally accepted opinion that this bacillus is non-motile, confirmatory evidence of this observation is necessary, but Mr. Nelson's skill and experience, and above all, his caution, make the statement one that must be received with respect. Mr. Nelson states that he has observed bacilli with single flagella, and others, with a flagellum visible at each end. He gives the uncorrected length of the bacillus as 2·94μ long, and ·34μ broad, and the length of the flagellum as 1·24μ.

At a recent meeting of the Royal Microscopical Society, Dr. Hebb read the following further communication from Mr. Nelson, which will interest many microscopists:—"It may interest you to hear that the flagella of the tubercle bacillus can be seen with a dry lens. The apochromatic 4 m.m. (long tube), by Zeiss, and the 7a (short tube), by Leitz, both will demonstrate the flagellum. There is nothing of particular interest in this of itself, but there is one point worth noting, which is, that it is only the bacilli stained with fuchsin that will shine on a dark ground; other objects in the field, such as nuclei stained blue, hardly show up at all upon a dark ground. Therefore, if the flagellum was, as has been said, some other object stained blue and lying fortuitously against the bacillus, it never would have been seen upon a dark ground. The image is necessarily a difficult one, even shining as it does with the fuchsin in it, but unless it was an integral part of the bacillus, and took the stain with it, it would be perfectly invisible."

In reference to the remarks made above as to the beaded appearance of tubercle bacillus, Mr. Nelson calls attention to the fact that improved methods of staining show the unit cell to be square ended, the apparent distance between one cell and the next is much reduced, and the whole bacillus looks something like a jointed bamboo; the resolution of these joints has become proportionately more difficult, and can no longer be performed by quite low powers.

As branching forms of this organism have been seen by other observers, as well as clubbed and swollen shapes, and gland-like clusters in experimentally affected animals, the evidence seems to be accumulating that *Bacillus tuberculosis* should not be included amongst the monomorphous bacteria, and does not represent a single bacillus, but belongs rather to fungi of the nature of actinomyees, and that the name "tubercle fungus," would be in the meantime preferable.

New Form of "Erlich" Eyepiece.

Messrs. R. and J. Beck, Ltd., have brought out a new form of "Erlich" eyepiece for counting blood corpuscles. It is of the standard students' size (R.M.S. No. 1 gauge), and is provided with a square aperture which is adjustable by means of an external and graduated wheel, and can be varied from 1 mm. to 8 mm., so that it can be instantly set to the most convenient size. The actual area to which the size in use corresponds when used with any particular object-glass is ascertained by slipping a stage-micrometer on the stage of the microscope.

New Oil Immersion Objective.

Messrs. A. E. Staley and Co., have sent me, for examination, a new 1-16th inch homogeneous immersion objective, with a numerical aperture of 1·3, made by the Bausch and Lomb Optical Co. The use of a lens of this magnification is limited, as it is an axiom of modern microscopy, that resolution is dependent upon aperture and not on mere empty magnification, but given a certain aperture, and consequently a proportionate resolving power—that is, for example, an ability to resolve a certain number of lines to the inch—it still is necessary for these lines to be magnified sufficiently to enable the human eye to distinguish them. It is here that the personal factors come in. Some observers have keener vision than others, either by nature or by training, and I have myself found that the average observer needs an object to be magnified to a point possibly beyond that of best definition if he is to see it to his satisfaction. But most objectives will not stand really high eye-piece magnification, and the higher the power of the objective, the less will they bear a high eye-piece. It is therefore sometimes advantageous to obtain a given magnification by increasing the power of the objective, and contenting oneself with a lower eye-piece, and many workers find an objective of moderately increased power, such as a 1-16th inch, easier to work with on difficult objects than a 1-12th inch of the same aperture, and equal theoretical resolving power. Of the lens under notice, I can speak highly. Its definition is excellent, and its working distance ample. I have tested it on some difficult spirilla, as well as in more theoretical ways, and was much pleased with its performance.

Microscopical Material.

By the kindness of Mr. Edwin R. Gill, of Poole, I am able to offer to such of my readers as care to apply for it some specimens of *Drosera* (Sun-dew). Applications must be accompanied by a *stamped and addressed envelope*, and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

Notes and Queries.

Floatings of Foraminifera.—Mr. F. Mockler, of Bath, will be glad if any reader can tell him where he can get some floatings of Foraminifera, which will give him some *Nodosaria* and *Dentalina*.

Staining Yeast Nuclei (*B. C. H., Bradford*).—Yeast nuclei are very difficult to stain, and to see when stained. They must be first fixed with weak Flemming's solution, and then stained with such nuclei stains as saffronin, orange G, or gentian violet. The first of these stains is perhaps the best, though it takes rather longer than the others. Before staining, the fixing solution must be washed out by irrigation methods, and after staining irrigated in a similar way with alcohol and oil of cloves.

Volcanic Dust from Mont Pelée Eruption.—Mr. W. A. Rogerson, of Longsight, writes in reply to the enquiry of the Rev. W. Hamilton Gordon: "I have a little volcanic dust from Vesuvius, collected on a steamship, in the Bay of Naples, on the deck of which it lay an inch deep. A little of this dust was mixed with benzole, and well shaken upon settling. A slide was arranged with a drop of benzole solution of Canada balsam, a little of the dust from the benzole washing was then put into this drop of Canada balsam and well stirred with a needle; a cover glass, with the lower surface smeared with Canada balsam was then lowered on the dust, and the whole slide left to dry on the oven. The mounted slide should be examined with polarized light, when the particles of contained silica show up very clearly."

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for July .

By PROF. A. FOWLER, F.R.A.S., and
W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.48 and sets at 8.18; on the 31st he rises at 4.23 and sets at 7.49. On the 3rd, at 7 a.m. the earth is at its greatest distance from the sun, the solar parallax then reaching its minimum value of 8″·66.

Notwithstanding the declining solar activity, sun-spots and solar prominences are still fairly numerous. Eruptive, or metallic, prominences, however, have lately been of somewhat rare occurrence.

There is a partial eclipse of the Sun on the 21st, but no part of the phenomena will be visible in this country, the favoured regions being the South Atlantic, the Falkland Islands, and S. Patagonia. At the maximum phase about one-third of the Sun's disc will be obscured.

The positions of the Sun's axis and equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 30 ..	3° 32′ W	2° 55′ N	59° 54′
July 5 ..	1° 0′ W	3° 27′ N	353° 44′
,, 10 ..	1° 17′ E	3° 58′ N	287° 33′
,, 15 ..	3° 33′ E	4° 28′ N	221° 24′
,, 20 ..	5° 45′ E	4° 55′ N	155° 12′
,, 25 ..	7° 55′ E	5° 21′ N	89° 4′
,, 30 ..	9° 59′ E	5° 44′ N	22° 56′

THE MOON:—

Date.	Phases.	H. M.
July 6 ..	○ Full Moon	4 27 a.m.
,, 13 ..	☾ Last Quarter	10 13 a.m.
,, 21 ..	● New Moon	0 59 p.m.
,, 28 ..	☽ First Quarter	7 56 p.m.
,, 4 ..	Perigee	11 18 a.m.
,, 16 ..	Apogee	0 6 p.m.

OCCULTATIONS.—The following occultation is visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time	Angle from N. point.	Mean Time.	Angle from N. point.
			p.m.		p.m.	
July 2	γ Librae	4·1	7·55	73°	8.52	329°

THE PLANETS.—Mercury (July 1, R.A. 8h 14m; Dec. N. 21° 27′. July 31, R.A. 9h 47m; Dec. N. 9° 9′) is an evening star throughout the month, reaching its greatest easterly elongation of 26° 39′ on the 15th. On the 1st he sets at 9.43, on the 13th at 9.22, and on the 25th at 8.35 p.m., but in consequence of the long twilight is not favourably placed for naked eye observation. The planet is stationary on the 26th.

Venus (July 1, R.A. 9h 3m; Dec. N. 18° 41′; July 31, R.A. 11h 17m; Dec. N. 5° 35′) is an evening star, and is a conspicuous object in the western sky after sunset. On the 1st she sets at 10.14 p.m., and on the 31st at 9.16 p.m. The apparent diameter increases from 13″·2 to 15″·8 during the month. Telescopic examination will show that the planet is gibbous, about three-quarters of the disc being illuminated. The planet is in conjunction with the crescent moon on the 24th at 7 p.m., the planet then being 1° 23′ to the south of the Moon.

Mars is not observable this month, being in conjunction with the Sun on the 15th.

Jupiter (July 1, R.A. 5h 32m; Dec. N. 22° 56′; July 31, R.A. 6h 0m; Dec. N. 23° 8′) is a morning star throughout the month, rising at 2.46 a.m. on the 1st, and at 1.14 a.m. on the 31st. He will be found in the eastern part of Taurus.

Saturn (July 1, R.A. 23h 8m; Dec. S. 7° 39′; July 31, R.A. 23h 4m; Dec. S. 8° 8′) is coming into a more favourable position for observation, rising at 11.7 p.m. on the 1st and at 9.31 p.m. on the 31st. He is describing a retrograde path in Aquarius. The apparent axes of the outer ring at the middle of the month are respectively 43″ and 2″·6, while the polar diameter of the ball is 17″. The northern surface of the ring is presented to the earth.

Uranus (July 16, R.A. 18h 25m; Dec. S. 23° 28′) is rather low in our latitudes, but is otherwise well placed for observation. The planet is in Sagittarius and rises at about 7 p.m. near the middle of the month, and then crosses the meridian at 10.50 p.m.; it will be then about three quarters of a degree east, and nearly two degrees north of λ Sagittarii (mag. 2·9). Its remarkable spectrum of broad dark bands is well worth the attention of observers, even though possessing only small instruments.

Neptune is not observable this month, being in conjunction with the Sun on the 2nd.

METEOR SHOWER.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. 22 h. 6 m., Dec. S. 11°, and the meteors are slow with long trails.

TELESCOPIC OBJECTS (double stars, &c.):—5 Serpentis, XV.h 13m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.h 41m, N 15° 44′, mags, 3·8, 10; separation, 31″.

θ Serpentis XVIII.h 51m, N. 4° 4′, mags. 4·0, 4·2; separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei XXII.h 1m, N. 64° 8′, mags. 4·7, 7; separation, 6″.

δ Cephei XXIIh 26m, N 57° 56′, mag. 4·2, 7; separation 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being 5d 9h, with a sharp rise from minimum to maximum in 1d 9h. There will be minimum on the 2nd at 3 a.m., from which succeeding minima and maxima may be calculated by the intervals given.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree north of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633; about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.